POWER

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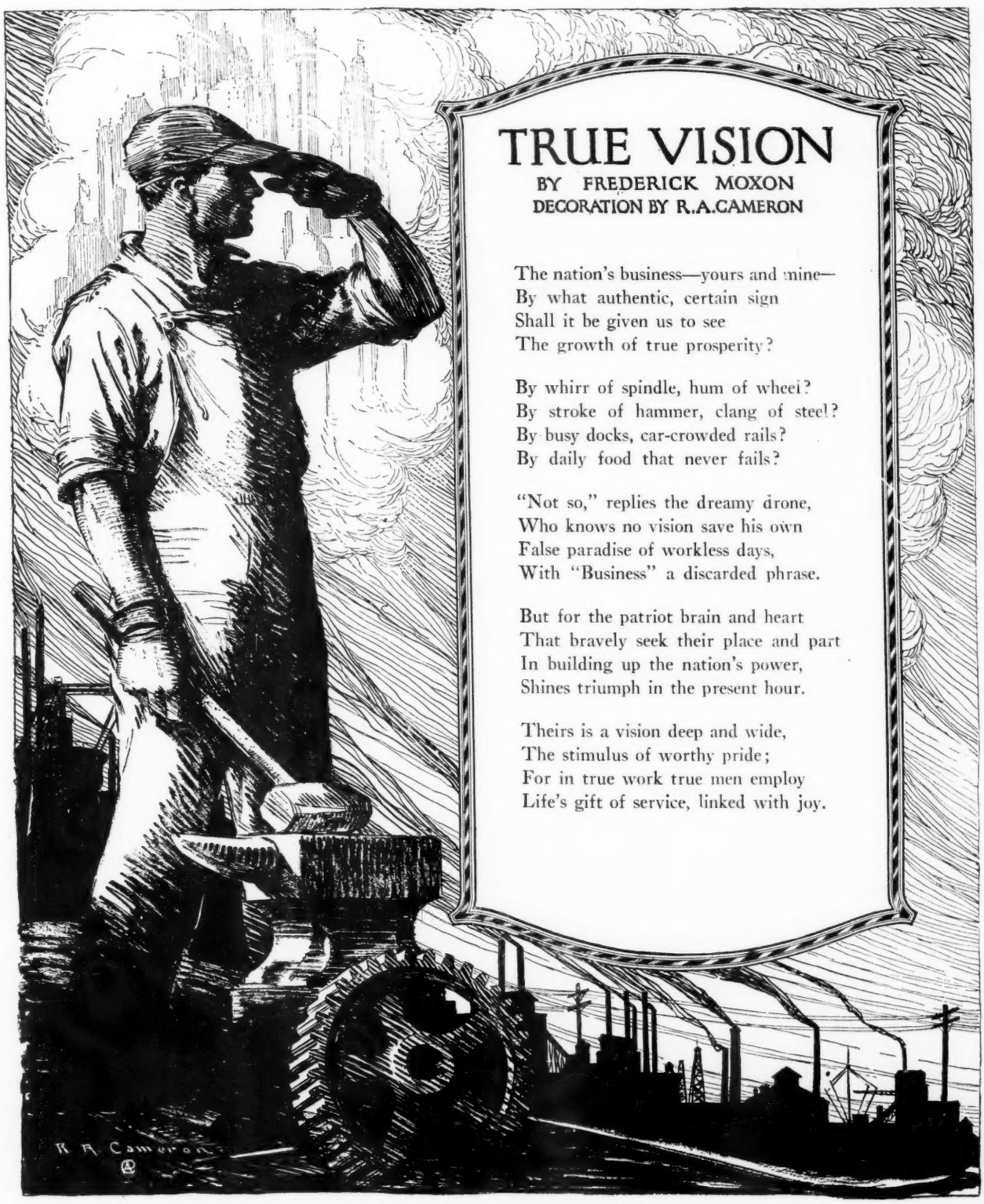

TRUE VISION

BY FREDERICK MOXON
DECORATION BY R.A.CAMERON

The nation's business—yours and mine—
By what authentic, certain sign
Shall it be given us to see
The growth of true prosperity?

By whirr of spindle, hum of wheel?
By stroke of hammer, clang of steel?
By busy docks, car-crowded rails?
By daily food that never fails?

"Not so," replies the dreamy drone,
Who knows no vision save his own
False paradise of workless days,
With "Business" a discarded phrase.

But for the patriot brain and heart
That bravely seek their place and part
In building up the nation's power,
Shines triumph in the present hour.

Theirs is a vision deep and wide,
The stimulus of worthy pride;
For in true work true men employ
Life's gift of service, linked with joy.

U.S. Nitrate Plant No. 1

By
Edward R. Welles*
and C. T. Mitchell

POWER STATION FOR U. S. NITRATE PLANT NO. 1 AT SHEFFIELD, ALA.

A modern plant of 5000 kw. capacity in turbo-generators and eight water-tube boilers of 5016 sq.ft. heating surface each, operating at 200 lb. pressure and 125 deg. F. The three main turbines are of the bleeder type for furnishing process steam for the process of nitrogen fixation.

A 5000-kw. steam power plant forms part of the equipment of the nitrogen fixation plant built for the War Department at Sheffield, Alabama, for the production of ammonium nitrate by The J. G. White Engineering Corporation. This power plant is not directly comparable to the average lighting or power station since a considerable proportion of the total steam produced is used directly in the process.

The building itself is 165 x 77 ft., one end of this rectangle being occupied by the boilers, the other end by the turbines and electrical equipment. Space in addition to the above area is occupied by two radial brick stacks, a cooling pond, an adjacent water-softening plant and a small extension to the main building to accommodate two air compressors. Another small extension on the boiler-room end forms the coal-elevator shaft and also houses a stairway leading to the top of the building. In external design the building conforms with the other principal buildings of the plant, the walls being of red brick with limestone belt course, window trim and cornice. Ample window space has been provided, with the result that the boiler room is as cool in warm weather as any other part of the building.

Coal, on being received, is either unloaded in the storage yard by a locomotive crane or dumped directly into the coal pocket at the boiler room. The pocket consists of a steel hopper 10 x 12 ft. in plan with a reciprocating feed at the bottom delivering to two crushers with rolls 28 in. diameter by 30 in. long. Each crusher delivers to a bucket elevator having 20 x 20-in. buckets spaced 36 in. apart. These elevators become conveyors at the top of the bunker over the boilers and distribute the coal, with a capacity of 100 tons each per hour. The bunker is of the straight-sided hopper bottom type, built of concrete in structural steel framing and holding 500 tons of coal. Ten gates, 16 x 16 in. square deliver the coal to a weighing larry operated by two ropes from the boiler-room floor. This larry is moved from gate to gate with the assistance of a 2-hp. motor, as needed, interlocking with the gate and releasing a catch which otherwise prevents the gate from opening. Before passing to the stoker the coal is weighed in the larry by the attendant, the weight being recorded.

The boiler-room equipment consists of 8 Stirling boilers rated at 502 hp. each, built with brick settings in four batteries facing each other across an 18-ft. aisle space. High-temperature cement was used in the settings in place of fireclay wherever the brick is exposed directly to the fire. Each boiler is designed for a working pressure of 200 lb. and has a heating surface of 5016 sq.ft., making the total heating surface 40,128 sq.ft. The high ratio between the boiler heating surface and kilowatts generated is explained by the fact that a large proportion of the steam is used in the chemical process as already noted. Each boiler is equipped with soot blower and superheater, the normal superheat being 125 deg. Soot, after being blown from the tubes, is collected in a hopper back of the mud drum and passed through a chute to the ash

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cars below. A CO_2 recorder on each boiler keeps the fireman constantly informed as to the status of combustion. Each row of boilers is served by a separate smoke flue and stack, the flue being rectangular in section mounted directly behind the boilers, with hollow tile floor and roof and 8-in. brick walls plastered inside with cement. The usual steel breeching connects each flue with the stack. The stacks are 10 ft. inside diameter at the top and 200 ft. high above the base, or 182 ft. high above the boiler-room floor.

A five-retort underfeed stoker serves each boiler. The eight stokers are operated by four vertical cylinder engines placed directly on the boiler-room floor, where they are easily accessible. Each engine has sufficient capacity to operate four stokers. Shafting running under the floor transmits the motion from the engine to the retorts by means of chain drives. Air is supplied to the stokers through a rectangular steel duct from four conoidal multiblade stoker fans mounted in the basement below the boilers. These fans are direct connected by flexible couplings to four steam turbines and operate normally at 2090 r.p.m. The stoker feed is controlled by means of a device operating directly on the throttle of the stoker engines, and actuated by the pressure in the windbox. The windbox pressure is again automatically controlled through a regulating valve by the steam pressure. A hand-operated reversible ratchet and worm-wheel device serves to dump the ash into concrete-lined ash hoppers below, from whence it is removed in hand-pushed side-dump cars, and distributed over the low ground surrounding the plant.

The capacity of the stokers is sufficient to operate the boilers at 200 per cent. of their normal rating, though it was not anticipated that such a high rating would have to be maintained except in rare emergencies. Since the power load and the demand for process steam would remain very constant, it was deemed advisable to have sufficient boiler capacity to be able to operate at between 125 per cent. and 150 per cent. of rating, which is the point of highest economy.

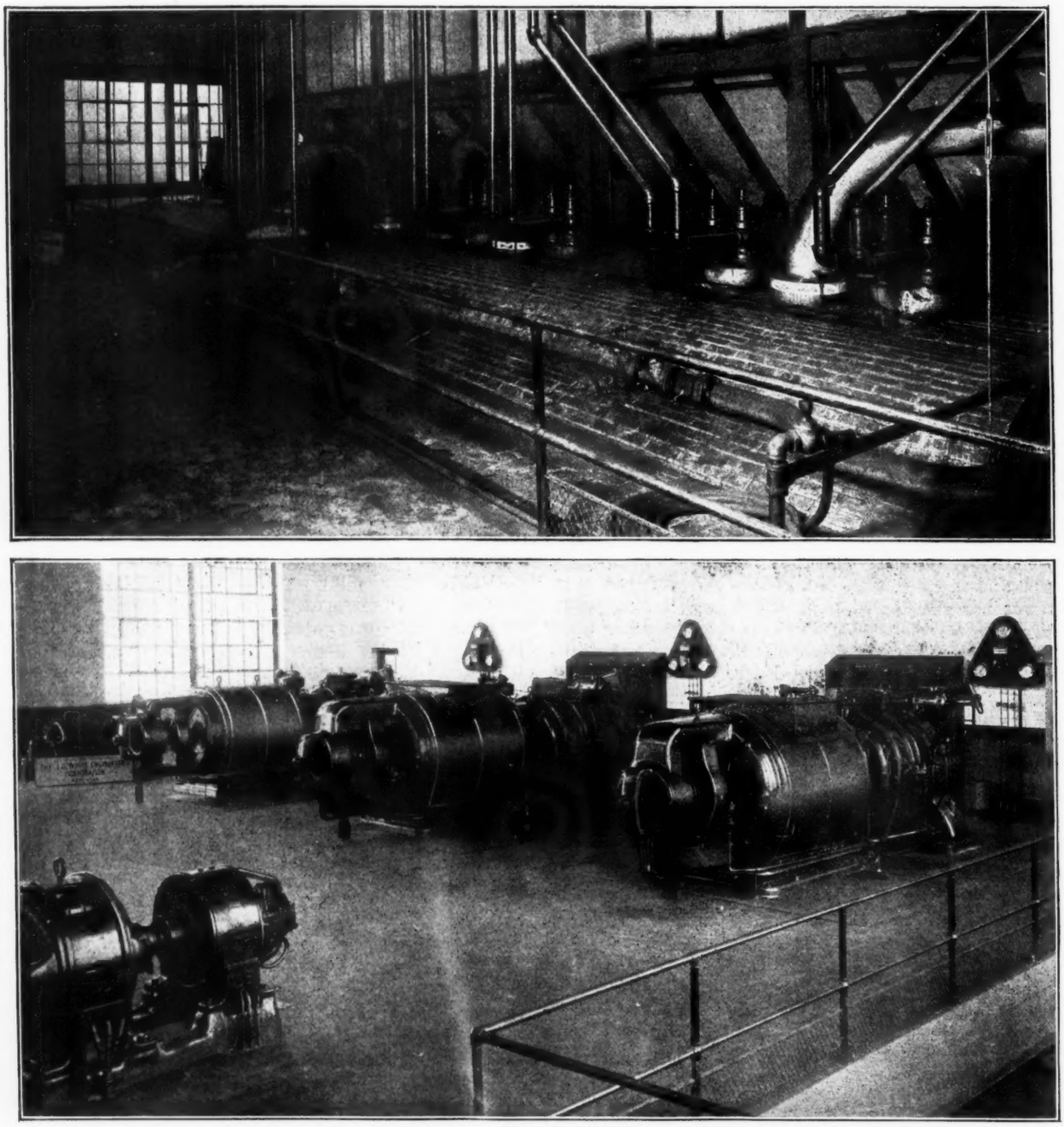
Three four-stage centrifugal boiler-feed pumps supply the water to the boilers, each pump being direct connected to a single-stage steam turbine. Any two pumps are amply large to supply the total amount of feed water, the piping being so arranged that any pump may serve any boiler or group of boilers. Venturi meters are installed on the feed line with recording integrating attachments to measure the flow. Each boiler is equipped with a thermostatic expansion-tube type of feed-water regulator, which in conjunction with pump governors affords complete automatic control of the feed-water supply.

The feed pumps receive their water from an open-type feed-water heater having lime-catching and heating surface of about 1000 sq.ft. This heater is located high enough to afford a head of about ten feet on the suction side of the feed pumps. It receives the exhaust steam from the stoker engines, vacuum pumps, circulating pumps, and from two air compressors. By means of a thermostatic valve operating a bypass from a ten-pound exhaust line leading to the process, the required temperature in the heater is maintained constant. The heater may receive its water from any one of three sources: Directly from the water main; from the cooling pond through the circulating pump line; or, normally, through the water softener. All sources of water lead back eventually to the pumping station at Spring Creek, a tributary of the Tennessee River. During periods of settled weather the water is received from there in a state of sufficient clarity for boiler-feed and cooling-water purposes. A large gravity filtering plant removes all sediment from the water in times of stormy weather before delivering it to the plant.

As the water contains a certain amount of lime and

SHOWING THE SPRAY COOLING POND IN BACK OF THE STATION

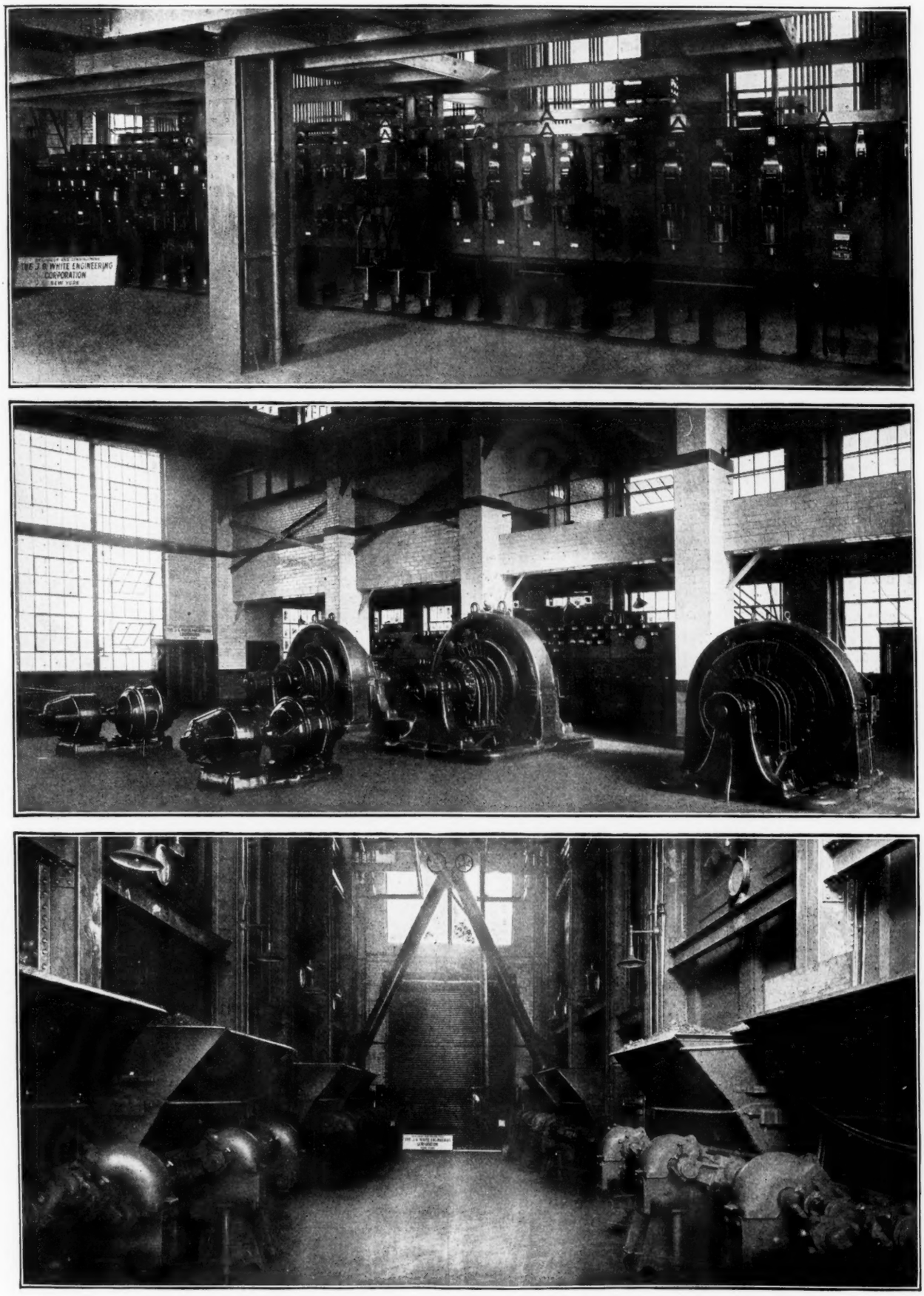
other scale-forming material, a water-softening plant was installed adjacent to the power house, consisting of a steel settling tank 21 ft. in diameter by 42 ft. 6 in. high, together with mixing and stirring devices and quartz sand filter. Water is received from the ammonia-process building where it has been warmed in passing through apparatus to from 100 to 120 deg. about six hours, then passes by gravity through a sand filter directly to the feed-water heater. A float valve on the settling tank controls the admission of water to the softener, in accordance with the demand of the heater. Complete flexibility of piping is arranged for so that the softener may be bypassed, or water either from the main or the cooling pond may be passed



TOP: AN UNUSUALLY CLEAN AND ROOMY SPACE ABOVE THE BOILER TOPS. BOTTOM: THE STEAM SIDE OF THE ENGINE ROOM

These few degrees above the average temperature of about 70 deg. offer a certain assistance to the softening process and represent a slight thermal credit in the heat balance. This water is forced to the top of the softener by one of two centrifugal pumps direct connected to a 15-hp. motor. Here it is automatically mixed with the proper amount of softening material and delivered to the settling tank, where it remains through it as well as the water from the process. A venturi meter records the flow through the softener.

The generating part of the plant is embodied in three bleeder turbines, one of 1250 kv.-a., and two 1875 kv.-a. capacity. The reason for this divergence in size is that the smaller unit had already been purchased by the General Chemical Co. to be used in a nitrogen fixation plant of their own before the Government adopted their



SOME INTERIOR VIEWS OF THE POWER PLANT
Top: The switchboard. Middle: The electrical side of the engine room. Bottom: The boiler room.

process and took over whatever equipment had been ordered, with the intention of using it in the larger plant now in operation. These turbines are interesting in that they possess a large diaphragm valve operating in the main body of the shell which automatically releases sufficient steam at the 10-lb. pressure stage to maintain 10 lb. in a line running to the process part of the plant. The main body of the steam in this line consists of the exhaust from two low-pressure air compressors, the boiler-feed pumps, the forced-draft fans and the exciter (when running). The turbines supply from 10 per cent. to 30 per cent. of the steam, according to the number of units of the process in operation. They also act as a pressure regulator in the exhaust line, this being the most important function of the bleeding operation. The generators operate at 3600 r.p.m. and deliver at 190 volts 60 cycle six-phase. As direct current is chiefly used in the plant, most of the current generated is converted in three rotaries located opposite the turbines on the turbine-room floor. An air washer in the basement with a capacity of 21,600 cu.ft. per minute cleans all the air that passes through the turbines; a batch-type oil filter, also in the basement, receives the oil from any one unit when shut down, filters the oil and returns it by means of a small plunger pump.

Low-Head Jet Condensers

The condensers, located directly beneath the turbines, are of the low-head jet type. They receive their condensing water from a concrete trench connecting directly with the cooling pond. Each condenser is protected by a 14-in. atmospheric relief valve. A 12-in. circulating pump removes the water from each condenser and delivers it to the sprays against a total head of not over 35 ft. Each pump is direct-connected to a steam turbine, operates at 2600 r.p.m. and delivers 1730 gal. per minute. The shafts of the pumps are extended to admit of possible future motor connection. Three 8 x 20 x 12-in. horizontal single-stage rotative dry vacuum pumps complete the condenser equipment. The fact that a considerable proportion of the total steam is used in the process and is not recoverable, had a determining influence on the choice of type of condenser. Each condenser is equipped with a recording thermometer.

A 24-in. cast-iron pipe conveys the water from the circulating pumps to the spray pond, a distance of about 90 ft. The pond itself is constructed of waterproofed concrete 167 ft. long by 100 ft. wide. Three lines of 10-in. asphalt protected pipe are supported over the surface, each line carrying fifty spray nozzles.

Four air compressors are housed in the power plant building, though not strictly a part of the equipment. Two of these machines are horizontal cross compound two-stage, delivering air at 100 lb. pressure at a displacement capacity of 632 cu.ft. per minute each. The air from these machines is used in the machine shop and ammonia-process building, also for operating boiler-tube cleaners, blowing out electrical apparatus, and assisting in the daily cleansing of the filter in the water softener. The exhaust from the steam cylinders is directed to the feed-water heater. The other two machines are tandem Corliss compound, compressing single-stage in the air cylinders and delivering air at 35 lb. gage pressure with a displacement capacity of 1395 cu.ft. each. This air is used entirely in the process. The exhaust steam from these machines is also delivered to the process in the 10-lb. pressure line previously referred to.

Steam-flow meters are installed as follows: on each turbine lead, on the line to the low-pressure compressors, and on a 6-in. high-pressure line to the process.

All high-pressure piping over 3½ in. in diameter in the power plant is made up with Van Stone ends and rolled steel flanges. All low pressure pipe over 12 in. in diameter is likewise made up with Van Stone flanges. All high-pressure steam valves are cast steel with monel-metal stems, seats and disks. Magnesia was used for all pipe insulation. All equipment throughout the plant is of the most modern, approved type.

[Considerable refrigeration capacity is required for the chemical processes in the nitrate-manufacturing buildings.—Editor.]

IMPORTANT DATA ON POWER PLANT OF THE UNITED STATES NITRATE PLANT NO. 1 AT SHEFFIELD, ALA.

BOILER ROOM

Dimension boiler room	75 ft. long by 80 ft. wide
Width firing aisle, ft.	18
No. of boilers	eight; 502 hp. each
Type of boilers	Stirling—0-23
Steam drums, three	42 in. dia. x 12 ft. 10⅛ in. long, ¾-in. plate
Mud drum	48 in. x 11 ft. 7⅞ in. long, 1-in. plate
Tubes	380, 3½ in. diameter
Heating surface, sq.ft., each boiler	5,016
Grate surface (active) sq.ft. per boiler	94.75
Heating surface per sq.ft. active great area	53
Heating surface per installed kilowatt, normal capacity of generators	8
Pressure, lb. per sq.in.	190
Superheat, deg. F.	125
Total steam temperature, deg. F.	509

Coal analysis upon which stoker performance is based, per cent.:

Fixed Carbon	Volatile	Moisture	Ash	Sulphur	B.t.u. per Lb.
70	22	1	7	1	14,200

Boiler settings, floor plan dimensions: 25 ft. 0 in. x 21 ft. 1½ in. (no arches)
Stokers, type, Westinghouse underfeed: 5 retorts per boiler
Stoker drive—Chain drive from vertical engines
Stoker performance: 76 per cent. combined boiler and furnace efficiency at 100 per cent. rating.
Forced-draft fans: Four Buffalo Forge No. 4½ Turbo conoidal type, direct-connected to Terry turbines, 2090 r.p.m., 51 b.h.p. each.
Coal handling: Railway cars dump into hopper service by bucket elevator to bunkers. Locomotive crane in yard.
Bunkers: Steel frame, concrete
Capacity of bunker: 500 tons
Coal to Stokers: One weighing larry serves all boilers
Soot blowers: Diamond type
Main steam valves: Walworth type
Automatic stop valves: New Bedford type
Blowoff valves: B. L. W. type
Size of steam header: 8 in.
Feed-water heater: One Hoppes type, horizontal, capacity 6,000 hp.
Heater capacity per rated horsepower capacity of boilers installed, boiler hp. 1.5.
Feed pumps, three, Alberger type.
Type, centrifugal 3 lb., four-stage, 200 gal. per min. at 2700 r.p.m. driven by Alberger-Curtis steam turbines.
Water softener, American, steel tank, tipper type, 25,000 gal. per hr. capacity.
Chimneys: Alphonse Custodis radial brick: Type 10-ft. top diam. by 182-ft. high above boiler room floor.
Coal burned per sq.ft., minimum cross sectional area at 100 per cent. boiler rating, lb. per hr. (based on four boilers per stack): 282
CO_2 Recorders: Uehling type, two machines recording gas from eight boilers

TURBINE ROOM

Three turbines, General Electric, one 1250 kv.-a., two 1875 kv.-a., Curtis, bleeder type, 60 cycle, six phase, 190 volts.
Steam which may be extracted from 1875 kv.-a. unit at 10 lb. gage for varying loads.

Load, Kw.	Lb. Steam Extracted	Flow of Steam to Condenser, Lb.
1875	24,000	19,900
1875	5,000	28,500
1405	38,000	5,850
1405	5,000	20,750
937	23,200	1,700
937	5,000	14,000

Speed: 3,600 r.p.m.
Excitation: 35 kw. 125 volts
Ventilation: One air washer, capacity 21,600 cu.ft. per min.
Oil-filtering system: Richardson-Phenix
Capacity: 24 gal. per hr., batch type
Three synchronous converters: General Electric type
Capacity: Two at 1700 kw., one at 1150 kw. 514 r.p.m.

CONDENSERS

Type	Low head, jet, Alberger type
Exhaust connection	Diameter, 1250 kv.-a. turbine, in. 30
Exhaust connection	Diameter 1875 kv.-a. turbine, in. 36
Removal pumps, centrifugal	Alberger type
Capacity, for 1250 kv.-a. unit	1730 gal. per min.
Capacity, for 1875 kv.-a. unit	2600 gal. per min.
Drive	Alberger-Curtis turbine with reducing gear
Pounds of condensing water to pounds of steam:	
Condensed, maximum conditions	43
Vacum pumps	8x20x12 in. horizontal, single-stage, rotative dry vacuum type
Spray pond, capacity	6000 gal. cooling water per min.
Size 167 ft. x 100 ft	150 nozzles

Improving Operation in Typical Industrial Plant Boiler Room

By J. T. BEARD, Jr.*

Driven to desperation because of shutdowns brought about by poor coal a manager decides to improve conditions in the boiler room. It is a typical plant where the usual causes of deplorable inefficiency have long existed, where the management refused the draft gages, scales and instruments so many times asked for by the engineer, and where collapse of operation was necessary before real measures of relief would be permitted. There is many an engineer who might with good effect hand the article to his management.

THE plant discussed in this article was confronted with problems of car shortage and "fireless coal," which sometimes ran as high as 60 to 80 per cent. ash. The fireman could not hold his steam and the plant had to shut down frequently. For the first time the manager realized that he had a boiler room and that it was an essential part of the plant. The effect of this sudden awakening was that the manager got a little madder, cussed and discussed the coal man, the Fuel Administration, and generally made life a little harder for the men around the plant. He did not see any connection between his predicament and those draft gages, coal scales and instruments which the chief engineer had asked for back in 1908.

Manager Realizes the Importance of Boiler Room

The situation at the plant got worse. Frequent shutdowns were not unusual, and the decreased production began to tell on the profit side of the sheet. He realized at last the vital importance of the boiler room and its continuous operation, and he decided that he must "right-about-face." He went further. He retained the services of a firm of engineers, expert in this line of work, to coöperate with his chief engineer and to assist and advise in the economical operation of the boiler room. "Economical" is not quite the right word, because he was not so much interested in economy at this time. His nightmare was "shutdowns." It was only after receipt of the Standard Questionnaire from the Fuel Administration that economy attracted his attention.

The plant contained three 250-hp. water-tube horizontally baffled boilers. They were equipped with flat grates and the coal was burned by forced draft. The average combined efficiency of boiler and grate varied from 48 to 51 per cent. This was not unusual, but is a fair example of the operating efficiency of the average industrial-plant boiler room. The dry flue-gas loss and the unburned carbon loss in the ash were high. Stack temperatures ran about 600 deg. F. and the average CO_2 in the flue gases showed about 4 per cent. Coal weights and production figures taken over a period of a week showed that approximately one ton of finished product was produced for every ton of coal used.

The grates were of the pinhole flat type. The function of a grate is twofold; namely, a mechanical means of supporting the fuel bed so that air may enter it from beneath and pass through it with the least resistance to its flow. The pinhole grate admirably fulfills the function of supporting the coal, but its 7 per cent. air space builds up such a resistance to the flow of air that the grate fails in its purpose. In this plant we find the peculiar situation where turbo-blowers were trying to force air through the bed, and pinhole grates with 7 per cent. air space were trying to keep it out. Furthermore, the pinhole opening produces a nozzle effect upon the air passing through it, so that as the air strikes the bed it has reached its maximum velocity and tends to blow fine coal off the bed and back into the combustion chamber. For this reason an apparent combustion rate of 18 lb. per sq.ft. of grate per hour may represent an actual combustion rate of only 10 lb. This is what happened at this plant.

Shaking Type of Grate Selected

Grates of the shaking type which gave 30 per cent. air space were selected. If the matter of the selection of grates was to be done over again, there is no doubt that the choice would be a grate of the pyramid type. The writer believes that in this grate we have the nearest approach to the ideal condition; namely, a mechanical support which prevents leakage, 30 per cent. air space permitting unimpeded flow of air, a reduction in velocity instead of an increase as the air reaches the fuel bed, a preheating of air as it strikes under the grate surface and a consequent cooling and preserving of the grate, a lateral deflection of the air as it passes through the bed instead of a straight vertical jet.

It was surprising to see that there were no uptake dampers either in the flue neck of the individual boilers or in the main stack. When the manager's attention was called to this, he innocently remarked that there had been dampers at one time but they were taken out because the boiler room would fill with gas when the automatic regulator closed the dampers.

Damper Regulation and Control

Damper regulation is dependent upon the condition of the fire bed and entirely independent of boiler pressure. In a forced-draft installation the function of the damper is to maintain the draft over the fire at about —0.05 in. of water. As holes burn in the fire bed, air rushes through more readily and there is a tendency to build up a pressure over the fire. If such a pressure actually exists, the flames and gas are forced out into the boiler room. To maintain the slight vacuum desired the damper is opened a notch or two as the pressure builds up in the furnace. A high vacuum over the fire is undesirable because of possible inleak-

*Engineer, Fuel Engineering Co. of New York.

age of cold air through the settings if the latter contain many cracks.

After investigation, it was decided that the proper draft conditions at this plant for the efficient combustion were: Ashpit, +1.2 in. water; furnace, —0.05 in. water. As the fire burns and holes appear in the fire, the ashpit pressure will decrease and there will be a tendency for the pressure to build up in the furnace. Proper adjustment of the uptake damper and the blower must be made from time to time to obtain the proper conditions. The plan of firing little and often was also introduced.

Referring to Fig. 1, the rate of burning of the coal is a function of the pressure drop through the fuel bed, or the difference between the ashpit and furnace pressures. When this pressure drop is at its maximum, as at *A*, the air supplied will efficiently burn a certain definite amount of coal per square foot of grate per hour. If more coal or less coal than this is fired, the result is either a smothering effect and incomplete combustion or a large excess of air and a cooling effect. As the fire burns out, the air rushes through more readily and the ashpit pressure falls off. At this time there is a tendency for pressure to build up in the furnace. Such a condition is represented at *B*, and the small pressure drop at this point indicates that the combustion rate of the coal has been materially decreased and that the large volume of air passing through the bed is seriously cooling the stack gases.

Now let the fireman coal up again at *C*. In doing this he covers the holes in the fire and a resistance to the air flow is again built up, which is evidenced by the increase in the ashpit pressure. There is also a tendency for the vacuum in the furnace to again be restored, and it may be necessary to adjust the uptake dampers to bring this down again to a balanced condition. The necessity of keeping the holes covered and of firing little and often is obvious. The practice at this plant was to smother the fire with 500 or 600 lb. of coal at a time and then sit down to rest for half an hour.

The dampers were restored to their proper places but not connected to the automatic regulator. Instead, the blowers were to be automatically controlled by means of a balance valve, and the dampers to be hand operated *as the conditions of the fuel bed demanded.*

Before the dampers were installed, the draft conditions due to the intermittent operation of the blower are represented in Fig. 2. Twenty-five per cent. of the time the blower was cut off. During these periods a heavy vacuum existed, not only in the furnace, but also in the ashpit, tending to suck in cold air through all cracks. During these periods the flue-gas temperature fell to about 300 deg. F., or 50 deg. cooler than the water in the boiler. It was not practical to cut one boiler out of the line, because the load was varied and uncertain.

After the dampers were properly installed and intelligently used, conditions were much improved. The resulting draft regulation is shown in Fig. 3. It was noticed that during the periods when the blower was cut off, the flue-gas temperatures reached a minimum of about 360 deg. This exclusion of the cold air from the boilers enabled the furnace to retain its heat for a longer time. For this reason the blowers were silenced for a much longer period and the fireman's work was much easier. In this way he accomplished exactly what he had tried to do by firing five or six hundred pounds of coal at a time and then resting. Besides this, the coal pile benefited considerably as will be shown later.

It was interesting to note the relation of percentage of CO_2 in the flue gas and the regulation of the draft during the observations at this plant. Fig. 4 shows

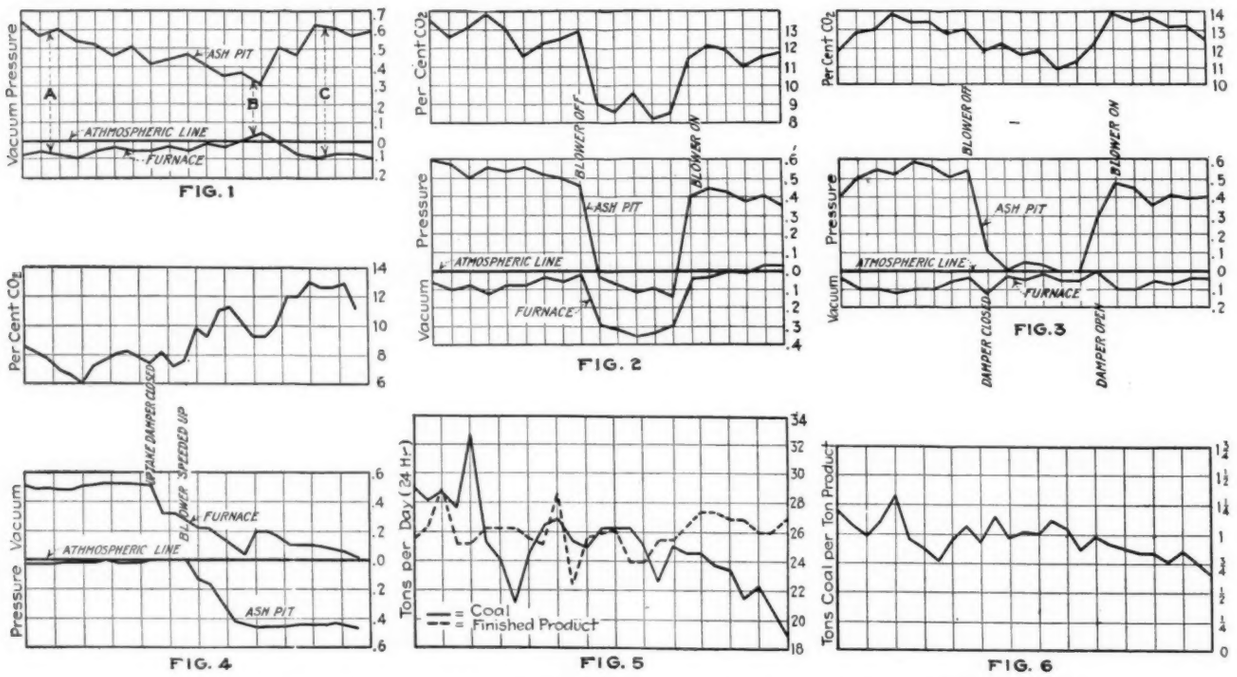


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

CURVE STUDIES IN BETTERING THE PERFORMANCE OF AN INDUSTRIAL POWER PLANT

the results of one of the preliminary observations. With a low ashpit pressure and the damper wide open, giving a high vacuum over the fire, the percentage of CO_2 in the flue gases was low. By speeding up the blower and closing the dampers a few notches, the same pressure drop through the fire bed was maintained, insuring the same combustion rate, while the CO_2 was increased to a desired value.

The boiler settings were made tight.

When the load was heavy, the flue-gas temperatures were about 600 deg. and sometimes went as high as 700 deg., indicating that the gases were being short-circuited through the boiler, or that the boiler was dirty. Both conditions happened to exist, and after a good overhauling this average temperature was reduced to 500 deg. F.

As a result of our efforts the daily coal consumption was reduced from 30 tons to 18 tons. Such a large saving was possible only because of the very wasteful condition of the plant in the beginning. The combined efficiency rose from 48 to 70 per cent., which is a good standard operating efficiency for any industrial plant.

More Production with Less Coal

During this work of coal conservation or, properly speaking, plugging leaks, the production at the plant was boosted to about 6 per cent. above its former point. In addition the coal mixture was reduced from 1 to 1 to 2 to 1. A further reduction to 3 to 1 was entirely successful, but the management was forced to call a halt because the supply of screenings ran low. The real test of the success of all these investigations was found in the office record. Formerly, one ton of coal was required for every ton of finished product turned out. At the present writing, a ton of finished product is being made for every five-eighths of a ton of coal, and the investigations are not yet finished. Fig. 5 shows graphically the relation between the production and coal tonnage of the plant. It is interesting to notice how the coal curve is on the decline. Fig. 6 shows that the curve of the ratio of tons of product per ton of coal is also on a similar decline.

The unburned carbon loss was reduced from 15 to nearly 3 per cent., which reduction was also partly due to greater care in cleaning fires. Still there was room for improvement. The CO_2 remained about 6½ per cent. average. This coking method of firing was found to be the most satisfactory in this plant. By this method the CO_2 was boosted to an average of 8.5 per cent., and after the settings had been made tight and proper draft regulation secured by means of uptake dampers, the average CO_2 was 10 per cent.

Summary of Changes Made

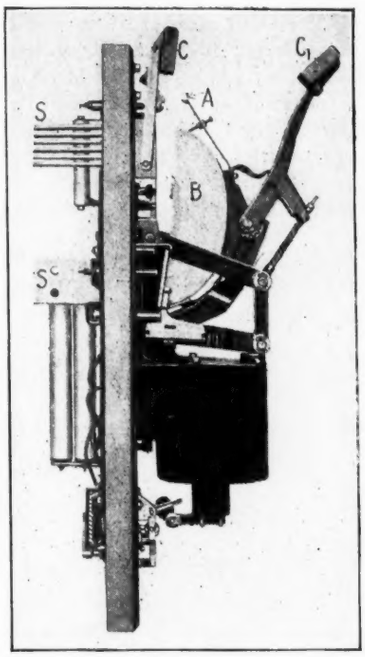
To sum up, then, the work at this plant involved:

1. Replacing the pinhole grate with a grate of proper design for the coal to be burned.
2. Installing uptake dampers and operating them by hand independent of automatic regulators. The blowers were then connected to the regulator.
3. Installation of draft gages and recording flue-gas thermometer. A CO_2 recorder was vetoed by the manager, but we have not given up hope.
4. Changing the method of firing from the "complete smothering method" to the "coking method."
5. Maintaining proper draft regulation involving a balanced condition over the fire.
6. Overhauling boilers and settings and putting them in good condition.

With regard to the question of instruments the idea is erroneous that consistent saving of coal can be made or increased economy effected without instruments.

New Type of Reclosing Circuit-Breaker

The figure shows an electromagnetically operated circuit-breaker built in 3000- and 4000-ampere capacities. This breaker is closed and held closed by means of an electromagnet, opens automatically in case of overload, short-circuit or voltage failure and remains open a definite time interval regardless of the cause of opening. In case the breaker is opened by a short-circuit, it will make no attempt to reclose while the trouble exists, but closes instantly upon the removal of short-circuit or overload. The main contact brush *B* is of a laminated - butt - contact type. The studs *S* are of laminated construction, the lower stud being slotted vertically and the upper horizontally. The main contact brush *B* is protected from arcing by an auxiliary copper contact shunt *A*, and the final arc is taken care of on the upper graphalloy contact tips *C* and C_1. The upper arcing tip *C* is carried on a pivoted support actuated by a strong compression spring so that it follows out at a considerable distance in opening, thereby insuring good contact of the arcing tips until the brush and auxiliary contact are separated from their respective contacts. The upper rear arcing tip *C* is also pivoted directly on its support so that it is free to align itself with the front contact C_1 in all positions. Provision is made for adjusting the tension of the main brush by means of an eccentric bushing in the brush support.



CIRCUIT-BREAKER IN OPEN POSITION

This breaker is built by the Automatic Reclosing Circuit-Breaker Co., Columbus, Ohio, and is particularly adapted to heavy-duty work such as is met with in steel mills and street-railway service.

One of the greatest forces of civilization has been the utilization of power to do necessary and useful work for mankind. The importance and dignity of generating and delivering power service in a usable and helpful manner should not be underestimated by those who make the doing of modern marvels possible. Every man's work is needed, and it must needs be done well or the quality of the entire output is affected.

How Spacing and Thickness of Brushes Affect Commutation

By WARREN C. KALB
Managing Engineer, Corliss Carbon Company

Discusses how the spacing, alignment and thickness of brushes may cause circulating currents to flow in the armature windings and thereby develop poor commutation.

IF GOOD commutation and cool operation are to be secured, it is necessary that the brushes be accurately spaced around the commutator. If the spacing is unequal, it is impossible to so shift the rocker arm that all the brushes are brought into the best commutating position at one time. When some of the brushes are placed in the proper position, those on another stud may be located ahead of the neutral position.

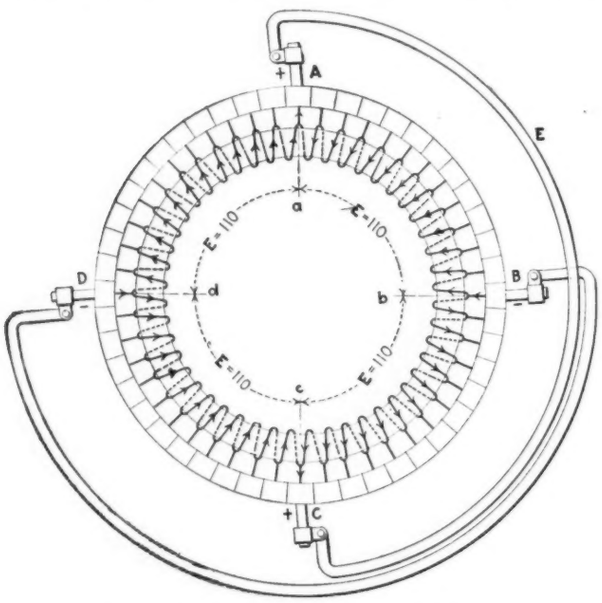


FIG. 1. BRUSHES EQUALLY SPACED

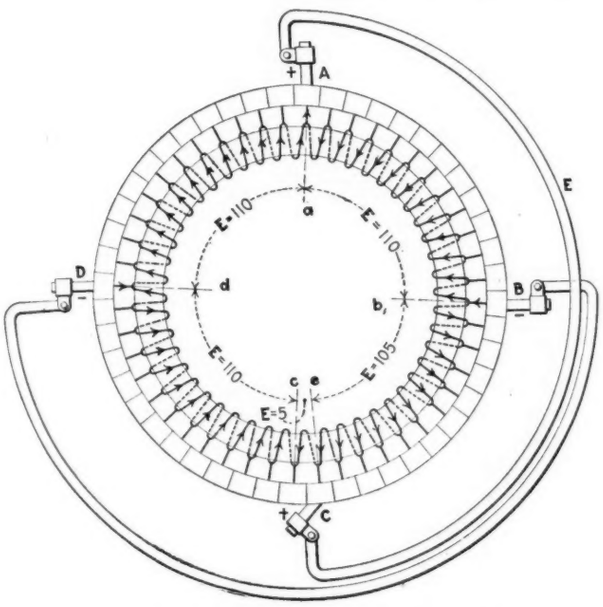


FIG. 2. BRUSHES UNEQUALLY SPACED

Brushes on still other studs may be located back of the neutral position, causing poor commutation. Unequal spacing of the brushes also puts an unequal number of turns in the different multiple paths through the armature. This is illustrated in Figs. 1 and 2.

In Fig. 1 the brushes are equally spaced and have equal voltages generated in the winding located between them, so that the 110 volts generated in the section between brushes *A* and *B* is opposed by 110 volts between *B* and *C*, likewise the 110 volts generated between *A* and *D* is opposed by 110 volts between *C* and *D*. Consequently no current will flow from brush *A* to brush *B*, which is just as it should be; if there were, we would have current circulating in the armature when there was no load on the machine.

Assume a condition as in Fig. 2 where brush *C* is shown displaced on the commutator to a position *e*. In this position assume there is only 105 volts generated between brushes *B* and *C*. This leaves a difference of 110-105 = 5 volts, available to cause a current to flow through the section of the armature winding *eba*. Now consider the left-hand side of the winding. Between brushes *D* and *A* there is 110 volts of a direction to cause a current to flow from brush *A* around to *C*, then to the left through the section of the winding *eda*. The voltage between points *d* and *a* is in the same direction as the volts between points *e* and *c*, consequently there is 110 + 5 = 115 volts opposed by only 110 volts in section *d c*. Therefore in the left-hand section of the armature we have 115 — 110 = 5 volts available to cause a current to flow from brush *A* around to brush *C* through the sections of the winding *e c d a*. In other words, there exists a difference of potential of 5 volts between brushes *A* and *C* to cause a current to circulate in the armature windings. The resistance opposed to this unbalanced voltage is very low, being merely that of two brush contacts, one-half the armature winding and the busbar *E*. This total resistance is so low that very small differences in potential can set up excessive circulating currents through the armature and brushes, resulting in severe overheating of the armature and sparking and glowing of the brushes. Tests have shown that the value of this current may exceed the full-load current.

With cast-in polepieces it is not uncommon to find the poles unevenly spaced around the frame, and the results in such cases are similar to those obtaining with unequally spaced brushes. The fault cannot be corrected by matching the brush spacing to the inequalities in the pole spacing. It can be overcome only by trimming the edges of the pole faces in such a way that the flux is given a symmetrical distribution around the frame.

With a series-wound armature uneven spacing does not result in circulating currents through the entire armature winding since there are no multiple paths in which such currents can flow. However, heavy local currents may be set up in the coil short-circuited by two adjacent brushes of the same polarity and their connecting bus.

Brush studs may at times be found unequally spaced when a machine comes from the manufacturer. However, this condition is quite the exception. One of the most common causes for inequality in brush spacing is found on machines having the holders clamped on round studs. Rocking the holder toward or away from the commutator changes the point at which the brush bears. Carelessness in setting the holders at different angles to the commutator may result in pronounced inequality in brush spacing. This is the condition illustrated in Fig. 2, where the brush studs are evenly spaced and the inequality in brush spacing is due entirely to the different angles at which the holders are set.

Brush spacing may be checked up by counting the number of bars in the commutator, dividing by the number of poles on the machine and seeing that this number of bars is between corresponding edges of brushes on all studs around the machine. This method is troublesome, however, where the span is not an integral number of bars. A better method is to cut a strip of paper or other nonelastic material to the exact length of the commutator circumference, mark it off in equal parts corresponding to the number of poles and secure it around the commutator. The brushes on all studs can then be set by these marks and equal spacing insured.

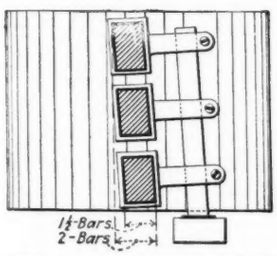


FIG. 3. BRUSHES OUT OF ALIGNMENT

Of equal importance with brush spacing is correct alignment of brushes with the commutator segments. Incorrect alignment is illustrated in Fig. 3. It may be due to poor alignment of brush studs, twisted commutator, or brush-holders set at different angles on the same stud. The effects are usually two-fold. Unless all studs on the machine are out of line in the same direction and by the same amount, unequal spacing of the brushes will exist with the results that have previously been described. An even more troublesome result may be the increase in the effective thickness of the brushes on the same stud. In the illustration the thickness of a brush is such as to span 1½ bars of the commutator but, due to the angle of the stud to the commutator segments, the three brushes span two full bars and the effect, as regards commutation, is the same as though a brush thick enough to span two bars were used. Where the brush thickness is originally chosen as large as the commutating characteristics of the machine will permit, bad commutation is an avoidable result of poor alignment.

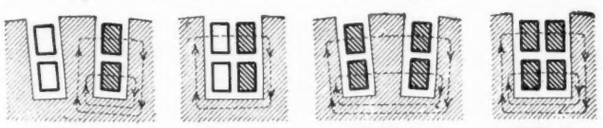


FIG. 4 FIG. 5 FIG. 6 FIG. 7.
FIGS. 4 TO 7. ARMATURE-WINDING SECTIONS

Assuming all mechanical conditions to be right and a brush free from all chattering or vibration, commutation is determined by the contact drop of the brush, its characteristic "sparking voltage" and the resultant voltage in the aramature coils short-circuited by the brush. By "sparking voltage" is meant the resultant voltage in the short-circuited coil below which no visible sparking occurs. The brush characteristic is somewhat different from contact drop. Of two brushes having the same contact drop, one may spark when short-circuiting a certain voltage, while the other does not. This is because the sparking voltage of the latter brush is higher than that of the former.

The voltage in a coil undergoing commutation is the resultant of several electromotive forces. The principal ones are: The voltage generated in the armature conductors due to the interpole flux or fringing mainpole flux; the volts generated in the end turns of the armature conductors due to whatever flux they may be cutting; and that due to self and mutual induction, commonly known as the reactance voltage. Opposed to this resultant voltage is the voltage drop across two contacts between the brushes and the commutator. The resistance of the armature winding and of the brush material itself is so small in relation to contact resistance as to be negligible in practically all cases.

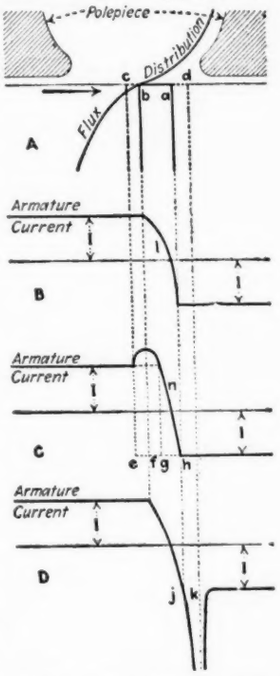


FIG. 8. FLUX DISTRIBUTION AND CURRENT CURVES

Whatever affects the reactance voltage of a machine is likely to have a pronounced effect on its commutating characteristics. In Figs. 4 and 6 are shown sections of an armature winding with two coil sides per slot. Figs. 5 and 7 show four coil sides per slot. Conductors undergoing commutation are represented by shaded cross-section. In the case of Figs. 4 and 6 the brush covers only one commutator segment and only one pair of the conductors is shown undergoing commutation at a given instant. In Figs. 5 and 7 the brush covers two segments and two pair of conductors are undergoing commutation simultaneously. The reluctance of the magnetic path through the armature core being negligible as compared to that across the slots, the latter alone will be considered.

In Fig. 4 the slot is one-half as wide as in Fig. 5 and the magnetic flux encircling the conductors undergoing commutation will consequently be twice as great. The brush in both cases covering one segment, the time of commutation will be the same. As a result of these conditions the reactance voltage in Fig. 4 will be twice that in Fig. 5. In Fig. 6 the reluctance of the magnetic path is the same as in Fig. 5, but there are twice as many conductors carrying current, so the magnetic flux is doubled. In this case, however, the brush

covers two commutator segments so the time of commutation is twice as long, equalizing the effect of the stronger magnetic flux and leaving the reactance voltage the same as in the case of Fig. 5. The same thing is true in the case of Fig. 7, where four coil sides are in the same slot.

Analyzing in a similar way the effects obtained with three or more coils, the following general conclusions may be drawn:

When the brush covers only one commutator segment, the reactance voltage is greater the narrower the slot.

The reactance voltage per coil remains unchanged, regardless of the thickness of the brush so long as the number of conductors simultaneously commutated does not exceed the total number of conductors per slot, as in Figs. 5 and 7.

The reactance voltage per coil decreases with increase in brush width where the number of conductors

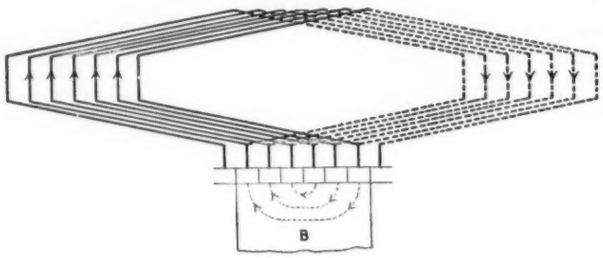


FIG. 9. BRUSH RESTING ON SIX SEGMENTS

simultaneously commutated exceeds the number of conductors per slot, as in Figs. 4 and 6.

The last statement would seem to impose no limitation on brush thickness so long as the number of conductors per slot is kept below the number undergoing commutation at one time. There are other limitations to brush thickness, however, which have to be considered.

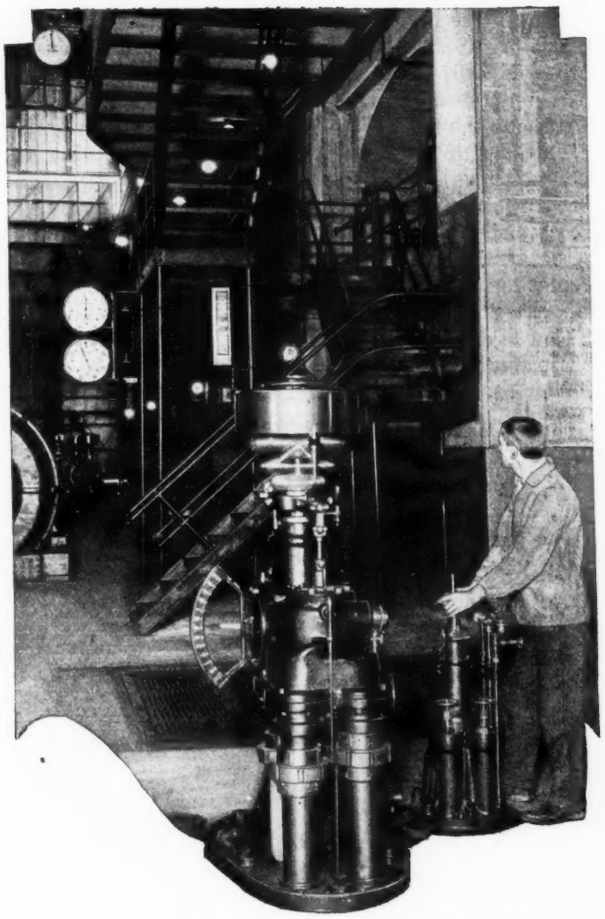
In Fig. 8 is shown at *A* the flux distribution curve of a generator with a brush of thickness *a-b*, so placed that commutation begins just as the coil is passing through the point of zero flux. The brush thickness is assumed to be so chosen for the load in question, that commutation is completed just as the coil has come into a reversing field of sufficient strength to have established a current of like value but opposite direction to that flowing in the coil before commutation began. This represents a condition of perfect commutation and is illustrated at *B*, the curve there shown representing the current flowing in the coil under consideration.

Now assume a brush of thickness *a-c* shown at *A* Fig. 8, to be installed with its leading edge at the point *c*. The coil about to undergo commutation would, in this case, be short-circuited while it was still cutting a flux that would generate an electromotive force in the same direction as the current flowing in the coil. As a result the current would increase until a reversing flux was encountered, as shown in diagram *C* at point *f*. The current would not reach its original value until some time later, as at point *g*, so that the actual commutating interval would be reduced from the time *b-a* or *f-h* to the time *g-h* and commutation would not be as good as was obtained with the thinner brush. Should the thicker brush be shifted to the position *b-d*, conditions illustrated at *D* would obtain. Complete reversal of the current would be attained at the point *j*, but the coil would still be short-circuited and would be cutting a field of increasing strength. The short-circuit current might rise to a very high value before reaching the point *k* where one segment passes from under the brush. This high current would then have to drop suddenly to the value *I*, and an arc would be drawn between the brush and the commutator segment leaving it. The result is sparking of greater or less severity, depending on the value the short-circuit current had attained. Experience shows that the brush thickness should not exceed one-twelfth of the pole pitch projected on the commutator surface.

Another limitation to brush thickness is illustrated in Fig. 9, where the brush *B* is shown resting on six bars of the commutator and short-circuting five coils of the armature. It will be seen that from edge to edge of the brush there is impressed a voltage equal to the total of the resultant voltages in all the coils short-circuited. The resistance of the coils and of the brush material itself being negligible, the only resistance opposed to this voltage is that of two brush contacts. In order that an excessive voltage may not be short-circuited, a brush should not cover more than three commutator segments on an armature with a simplex winding. With a duplex winding it is permissible to cover twice as many segments, other conditions being equal.

In considering the effects of brush thickness and spacing on commutation, voltages set up in the coils undergoing commutation and circulating currents established in the armature conductors are the only points to which attention has been turned. The other factors influencing commutation (namely, contact drop and sparking voltage) are characteristics dependent on the brush composition and method of manufacture. The influence of brush spacing and thickness on these characteristics is so slight that it will not be given consideration in this article.

No nation under the sun has the trade literature available which is prepared regularly for the American people. No matter what line of industry, what branch of public service, or what profession one may be engaged in, there is a wealth of high-class authoritative literature which is up-to-the-moment. Sometimes workers and executives become so busy with the near-at-hand details that they do not realize what they are missing when they allow their trade or technical publication to gather dust or to remain in the wrapper. It is interesting to remember that each issue of a modern publication costs large sums of money for the editorial matter, the articles of specialized interest, the cuts, the illustrations, the departments of service and the market forecastings. All this is aside from the materials and labor which go into physical makeup and quite apart from the advertising pages, which constitute a world market place brought to your office. This service is all offered on the coöperative plan for the absurd price of a few cents per month for what has cost thousands to produce. Yes, it does seem as though *there is something* after all for almost nothing! Even then a technical publication will be of little value to its recipient unless it is read, digested and part of its experience and helpful suggestions acted upon. Columbus discovered America with all its wealth of mines and fields and forests and streams, but he died in chains in Spain nevertheless, because he did not possess what he had found.



SYNCHRONIZING A MAIN UNIT AT HOLTWOOD

Operation at Holtwood

STARTING AND STOPPING THE MAIN UNITS

By Charles H. Bromley

Describes the procedure and precautions used in starting and stopping the large main units.

UNITS Nos. 1 to 5 at Holtwood are each of 13,500 hp. capacity, while units 6, 7 and 8 are each of 17,000 hp. capacity. Units 1 to 5 were built for 53 ft. head, while units 6 to 8 were built for 63 ft. head. Units Nos. 1 to 7 have double runners, while the last, or No. 8, unit has a single runner.

Normally, all turbines are started on hand control. The governorman first ascertains that the hand control valve is closed. He next opens the two hand-control balance-pipe valves located on the hand-control pedestal. He now opens the hand-control valve until the gates are about 30 per cent or even 40 per cent open, for a few seconds, so as to accelerate the unit as quickly as possible; then he closes the gates to approximately 5 per cent., followed by carefully opening them to about 10 per cent., the object being to get the unit at about 95 per cent. speed and then to let it pass to the normal speed mark, 94 r.p.m., slowly, so that the operator does not fail to get a shot in the least possible time. While doing this he watches the large (18 in.) illuminated-face synchronoscope mounted midway of the turbine room and visible from all hand controls from No. 1 to No. 8 machine (See the headpiece at the top of the page).

In the meantime the switchboard operator orders the generator disconnectors closed. The field, even on idle machines, is always adjusted for approximately normal voltage and is closed immediately after but not before the machine starts to revolve. For the guidance of the governorman the synchronoscope is cut in before the machine reaches the normal speed. Should the operator miss the first favorable shot, it requires from 10 to 20 sec. to restore normal speed, owing to the unit slightly overshooting the normal speed mark. Bad shots are not tolerated at Holtwood as they may induce severe water-hammer in the governor system and are injurious to the generator and generator leads.

The time of starting a machine ordinarily is not over a minute. The record time of starting from standstill to synchronizing on the board is 26 sec. made on No. 2 machine.

Transferring from Hand Control to Governor Control—When the unit is synchronized with the bus, it is transferred from hand to governor control. First, the governor pressure valve above the accumulator tank is

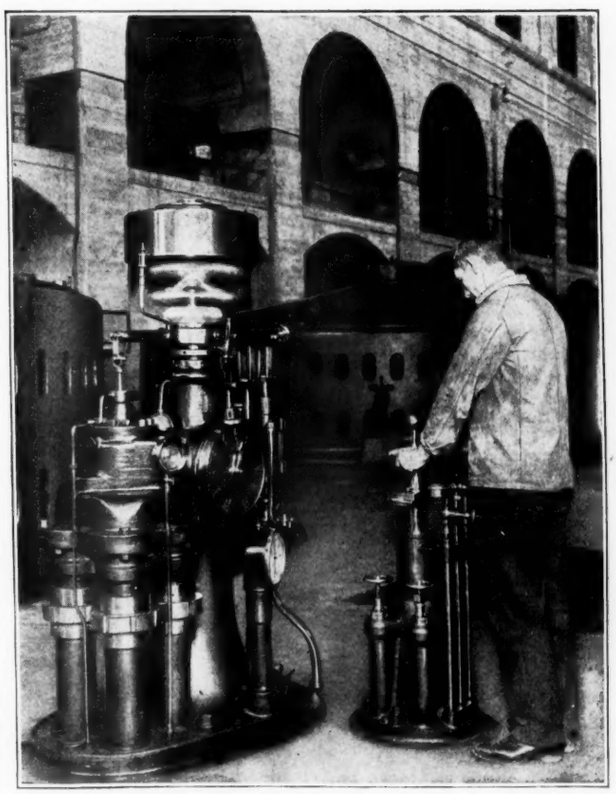


FIG. 1. CHANGING FROM HAND TO GOVERNOR CONTROL

opened and the governorman observes that the setting of the governor corresponds with the gate opening. The two hand-control balance pipe valves are now closed and the two generator balance pipe valves opened. The second valve is opened gradually at first as slight changes in adjustment may be necessary to the governor if the gate opening changes. The governorman now observes if the governor-control motor gear is engaged.

The collar jack-nut on the governor spindle is now run up until it is about one-quarter inch from the collar. From time to time as the load changes appreciably, the jack will have to be moved up or down; it is not permitted to be closer to the collar than one-quarter inch.

The governorman now signals the operator that the unit is under the governor control.

Transferring from Governor Control to Hand Control—The hand-control valve is set to correspond with the gate opening. Now the two balance-pipe valves are closed and the two hand-control valves are opened. The unit is now on hand-control.

The governor-pressure valve above the accumulator tank is closed. The governorman is seen making the transfer in Fig. 1.

When the unit is on hand-control the governorman or his assistant must be standing by to respond to the operator's signal to care for the machine in case of a runaway.

Shutting Down the Turbine—The operator drops the load on the machine and cuts out the generator oil switch. He then gives a stop signal upon which the governorman transfers the unit from the governor control to hand control, closing the gates and stopping the machine with a brake if necessary. Use of the brake in stopping the machine is necessary in order that the main thrust bearings for the mainshaft may not run at too slow a speed, thereby failing to get adequate lubrication.

While there is little hazard on account of a runaway generator, efforts are made to stop the machine immediately. Usually, such a runaway can be slowed to normal speed by operation of the governor or by hand control. Cutting in the large water rheostat on the runaway machine through the auxiliary bus and then closing the field switch will assist in stopping the runaway.

In case the governor is the prime cause of the runaway brought about through the spindle guide-bearing burning out or through stripping of the gears, sticking of the regulating valve, etc., a change is at once made to hand control. Should control of gates be lost, the unit must be slowed down by closing the headgates. This can be done rapidly on the gatehouse floor by releasing the holding brakes of the headgates, as shown in Fig. 2.

Should it happen that the generator with bad gate control cannot be spared, it is left on the auxiliary bus in parallel with the system, the water rheostat being kept ready to be thrown on the bus so that sudden loss of load will not permit the generator to run away.

FIG. 2. OPERATING THE HEADGATES BY MEANS OF MOTOR AND BRAKE

If the gate control on a generator is lost and the machine is needed for service, it is cut in and paralleled with the system by means of the headgates. After the wheelpit is filled with water, it is necessary only to raise one of the gates a small distance to keep the machine at speed until it is synchronized. When synchronized, its regulation is had by operating the headgates. One gate only is used if it will pass enough water to permit the turbine to carry the load; if not, two are opened. A man to operate the gate is, of course, stationed in the gatehouse during such times.

Synchronizing from Benchboard Without Any Attendant on Main Floor—The benchboard operator is also in a position to start a unit from standstill, bring it up to speed, and synchronize it single-handed from the benchboard gallery without the assistance of any governor attendent on the main floor. This is accomplished

by the use of the electric speed control provided for each generator on the benchboard, but requires, of course, that such a unit is on governor control when starting from standstill and that the air brakes, generally used for stopping a unit, had been released since the last shutdown. The speed of the unit does not respond as promptly to the benchboard control of the governor as

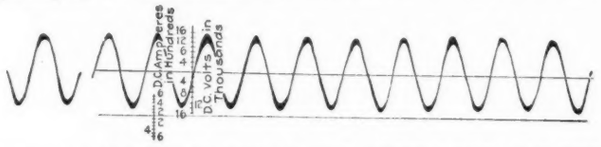


FIG. 3. VOLTAGE WAVES OF THE SYSTEM BUS AND THE INCOMING GENERATOR WHEN CAREFULLY SYNCHRONIZED

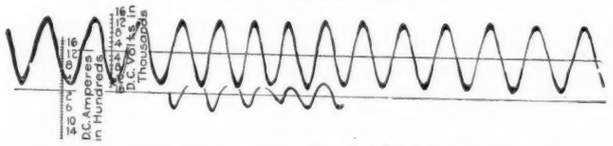


FIG. 4. BUS AND INCOMING GENERATOR WAVES, GENERATOR OUT OF PHASE 22½ DEGREES

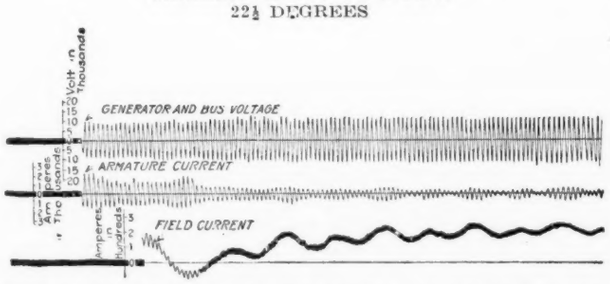


FIG. 5. OSCILLOGRAM MADE WHEN A UNIT IS PULLED INTO SYNCHRONISM AS AN INDUCTION MOTOR

to the more direct hand control. This method of starting up and synchronizing a unit without any floor attendant is rarely resorted to in the regular course of operation, as it requires a somewhat longer time than any other method in use. Depending on the dashpot adjustment of the governor, operators have been able to synchronize a unit in this manner from standstill in 96 sec. with the bypass open only a quarter of a turn, and even in as short a time as 65 sec. when the bypass was open two full turns.

Paralleling a Single Unit Without Synchronizing—At Holtwood the emergency may arise, especially during low-flow season, when a considerable portion of the load is carried by steam, that some unexpected trouble may develop in one of the three or four steam stations that may operate in parallel, and then it is imperative to pick up 10,000, 15,000 or even 20,000 kw. immediately. The normal method of synchronizing the needed generators is dispensed with at such a time. The slightest sign of any station being in distress, as indicated by drop in frequency, is the signal to cut in generators until the frequency is restored to normal. The operator displays the "Start" and "Fast" signals to the governorman, indicating that the unit is to be brought up to speed with all possible haste; he orders the generator disconnectors closed. As soon as the speed of the unit is approximately normal (within 5 per cent) the generator oil switch is closed, which causes the generator to operate as an induction motor and pulls the unit into synchronism. A moment later the generator field switch, which had been open from the last shutdown of the unit, is closed. The gates are opened, and the generator immediately picks up its quota of the load and brings the frequency to normal. The actual voltage disturbance resulting from such procedure does not exceed a momentary decrease of 4 per cent. to 8 per cent. and the load is not affected.

The time required to get a unit under load by this method is the time required to accelerate the machine and to get the generator oil-switch disconnectors closed. The rotating elements weigh 450,000 lb. each and the flywheel effect (WR^2) is 13,000,000 ft.-lb. The acceleration of the machine takes about 40 sec. and the closing of the disconnectors varies from 25 sec. to 50 sec., depending upon which unit is started and the distance its disconnectors are from the benchboard. When a large portion of the system load is being carried by other stations, the time required for closing the disconnectors is practically eliminated by having all disconnectors previously closed. In this case it is arranged that there are two open oil switches between the generator and the bus so that the accidental closing of one oil switch would do no damage. The generator itself is allowed to drift on vane leakage, or one unit may even be permitted to run at normal speed, thus eliminating the time required for acceleration.

Paralleling Several Units Without Synchronizing—An emergency condition may also occur when it becomes necessary to parallel several, or even all, units in the station in the shortest possible time. This can be done rapidly by closing in on the bus all generators, the field breakers of which had been tripped previously, and then simultaneously closing all the fields. The latter opera-

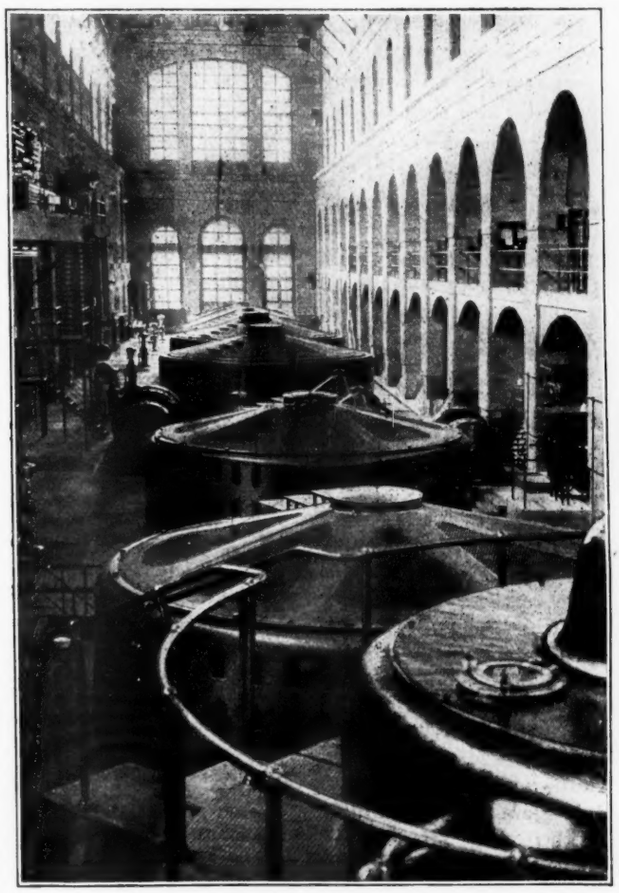


FIG. 6. THE GENERATORS AT HOLTWOOD

tion is done with a master field switch provided for the purpose. This method is resorted to only in the event of an interruption to service, when voltage is to be restored quickly to the bus or to the transmission lines.

Fig. 3 shows the voltage waves of the system bus and the incoming generator when carefully synchronized. The two waves appear as one, and no current disturbance occurred when the oil switch of the generator was closed.

How the waves appear when the bus and the incoming generator are considerably out of phase is shown in Fig. 4, where the generator was 22½ deg. out of phase There was violent disturbance when the oil switch pulled the wave into coincidence with the bus wave.

Fig. 5 is an oscillogram showing the effect of paralleling a single unit without synchronizing, the unit being pulled into synchronism as an induction motor.

Chart for Boiler-Test Results

By HERBERT B. REYNOLDS

All the lengthy calculations involved in working up the results of a boiler test in order to determine the evaporation per pound of fuel, the equivalent evaporation or the boiler horsepower may be dispensed with and the results found directly from the chart that forms the supplement to this issue.

ALTHOUGH the computations involved in obtaining the results of a boiler test are not at all complicated, they are more or less laborious due to the fact that they cannot be performed by a few consecutive slide-rule operations. In order to avoid these computations, and to save time and labor when there are a great many tests to be computed, the accompany chart has been devised. (See insert.)

The method of using the chart can be illustrated best by assuming an example. Suppose that the averages obtained from a given boiler test are as follows:

Absolute steam pressure, lb. per sq. in.	215
Superheat, deg. F.	140
Temperature of feed water, deg. F.	180
Feed water per hour, lb.	40,000
Moist coal fired per hour, lb.	4,600
Per cent. moisture in coal	2
Heating value of dry coal, B.t.u. per lb.	14,000

The solution of this problem is indicated by the dotted line on the chart, starting on the base line of the upper right-hand quarter of the diagram and proceeding around in a counter-clockwise direction through the remaining sections.

The average boiler pressure observed during the test is 215 lb. per sq.in., absolute. So, on the base line of the upper right-hand quadrant locate the point midway between 210 and 220, corresponding to 215 lb. per sq.in., and proceed vertically to the line marked 140, which indicates the degree of superheat of the steam.

From this point follow a horizontal line to the left, into the upper left-hand quarter of the diagram, until the diagonal line marked 180 is reached, this line indicating a feed-water temperature of 180 deg. F. Then drop vertically into the lower left-hand quadrant. This vertical line will cut the base of the upper left-hand quadrant at a point corresponding to 1.166, and that value is therefore the factor of evaporation for the steam and water conditions observed during the test.

Continue the vertical line until it strikes the inclined line marked 40,000, which is the weight of water evaporated per hour. Proceeding horizontally to the left from this point to the scale at the left-hand edge of the diagram, the equivalent evaporation will be found to be approximately 46,700 lb. per hour. On the other hand, proceeding horizontally to the right to the right-hand edge of the lower left-hand quadrant will show the output in boiler horsepower, which in the case under consideration is 1355.

Continue the horizontal line to the right until it intersects the diagonal marked 4600, corresponding to the number of pounds of coal fired per hour, and then turn vertically upward to the middle horizontal line of the diagram, where the scale will be cut at a point indicating 10.1 lb., the equivalent evaporation per pound of fuel fired.

But the fuel contained 2 per cent. of moisture. So, from the intersection of the vertical line and the diagonal line representing 2 per cent. of moisture in the fuel, proceed horizontally to the right, where the vertical scale will be cut at a point representing 10.3 lb., the equivalent evaporation per pound of dry fuel. Continue still farther horizontally to the right, to the diagonal marked 14,000, representing the heat value of the fuel used, and then follow vertically to the scale on the lower side of the middle horizontal line, where an over-all efficiency of 72 per cent. will be indicated.

In the upper right-hand quadrant one of the curves is marked Saturation Line. This line represents zero superheat, as marked, and is the line that must be used in case the steam is dry and saturated. If the steam contains 1 per cent. of moisture, use the line marked 0.99, corresponding to a quality of 99 per cent.; and if there is 2 per cent. of moisture in the steam, its quality is 98 per cent. and the line marked 0.98 must be used.

There is scarcely a day goes past when each one of us does not glimpse or even catch hold of a good idea somewhere. It may be how to tie one's cravat more deftly; or a soap or tooth paste that will prove more satisfactory; or a little twist, or turn, projection or indentation, that will make a machine run more smoothly. It may be an idea concerning any one of ten thousand things. If we let it get away from us, the chances are that the next good idea will be a little more elusive and difficult to grasp, and so we will cultivate the habit of unresultful mental attitudes. Thousands of fortunes are lost every year because good ideas are let go a-glimmering. One good idea put to work is worth while, and the beauty of it is that it makes us more capable to catch and use other good ideas, and further than that it makes us more alert and more discriminating as to which ideas are good and which are good for nothing.

A cement for securing leather lagging to iron pulleys can be made by adding to one quart of glue, dissolved in good cider vinegar, one ounce of venice turpentine. Allow it to simmer over a slow fire for about half a day and apply with a brush, then put on the leather and allow to dry for about two hours.

Scavenging in Two-Stroke-Cycle Diesel Engines

By NICHOLAS M. TRAPNELL

The purpose of scavenging is to clear the cylinder of burnt gases at the end of the power stroke and to fill it with fresh air ready for compression. This article describes methods of scavenging and types of scavenging pumps.

SCAVENGING in the two-stroke-cycle Diesel engine is accomplished by admitting air, at a pressure of from 3 to 6 lb. per sq.in., to the cylinder in such a manner that it forces the products of combustion out through the exhaust ports and fills the cylinder with air ready to be compressed on the next stroke of the piston. There are several methods of admitting the air to the cylinder. The first method used was by means of valves in the cylinder head, as shown in Fig. 1. As the piston *A* nears the end of the power stroke it uncovers the exhaust ports *B* in the bottom of the cylinder, which allows the exhaust gases to blow out into the exhaust pipe *C*. Shortly after the piston begins to uncover the exhaust ports, the scavenging valves *D* in the cylinder head open and allow the scavenging air to sweep down, forcing the products of combustion out through the exhaust ports and filling the cylinder

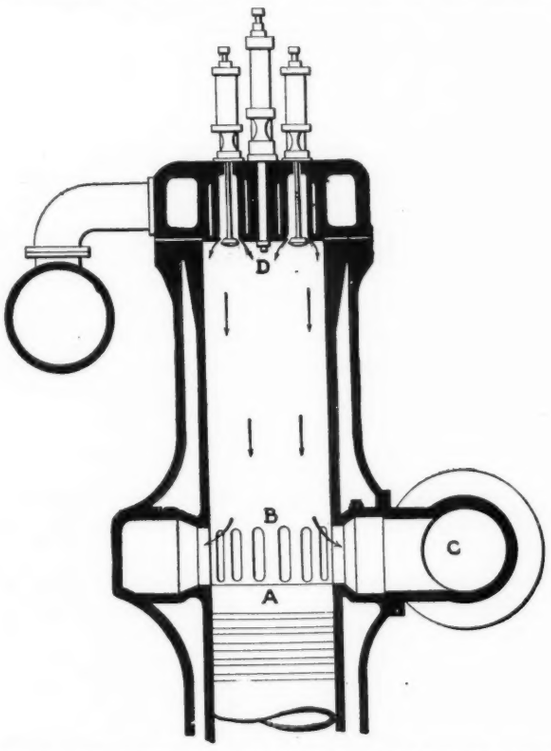


FIG. 1. SCAVENGING BY VALVES IN CYLINDER HEAD

with fresh air. The piston then starts on the return stroke and closes the exhaust ports after which the scavenging valves close and compression begins.

The scavenging valves are usually set to open some time after the piston has begun to uncover the exhaust ports, so as to allow the pressure in the cylinder to drop nearly to that of the atmosphere before the valves open; otherwise there is danger that the exhaust gases will back up through the scavenging valves into the scavenging-air receiver. The valves are usually set to close shortly after the piston has closed the exhaust ports, thereby allowing the pressure in the cylinder to build up to that of the scavenging-air receiver and giving a slightly higher pressure at the end of the compression stroke than would be the case if the scavenging valves closed as soon as the piston closed the exhaust ports.

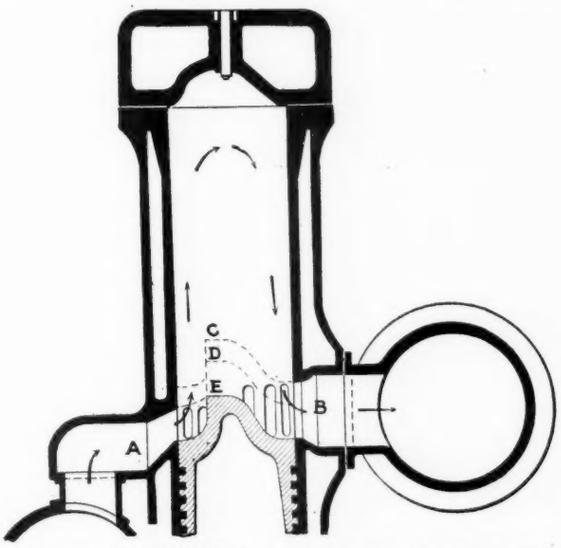


FIG. 2. SCAVENGING BY PORTS IN CYLINDER WALL

This method of scavenging is very rapid and efficient and is extensively used in the smaller engines; but, as a large valve opening is necessary to admit the required amount of air to the cylinder, usually two and often four valves per cylinder are necessary in the larger engines. This leads to excessive complication of the valve gear, especially in large engines, where six valves per cylinder would be necessary, including the fuel-inlet and starting valves. Also, the excessive number of valves greatly weakens the cylinder head, which should be pierced by as few openings as possible because of the high pressures and temperatures reached in Diesel-engine cylinders.

To overcome these difficulties a system of scavenging was developed which is now extensively used on large two-stroke-cycle engines. In this system, shown in Fig. 2, ports are used instead of valves. The scavenging ports *A* are arranged in the cylinder wall near the bottom of the cylinder, opposite the exhaust ports *B*. When the piston reaches the position *C* in the power stroke, it begins to uncover the exhaust ports *B* and allow the products of combustion to escape to the exhaust pipe. When the piston has reached the position *D*, the pressure in the cylinder has dropped nearly to that of the scavenging air and the scavenging ports *A* begin to open and admit the air to the cylinder. When the piston has reached its final position *E*, all ports are open wide. The incoming scavenging air is deflected upward by the shape of the piston, so as to drive out all the exhaust gases. On the return stroke, the

piston first closes the scavenging ports and then the exhaust ports, after which compression takes place.

This system is slightly less efficient than the valve scavenging system, but it does away with all scavenging valves and greatly simplifies the engine, as only two valves are necessary per cylinder—the fuel-inlet and starting valves—and in some cases only one, in case the starting valve is omitted. With this system the combustion chamber is not of the most efficient form, because of the shape of the piston. It should be as nearly symmetrical as possible and should contain no pockets or cavities. Also the compression is not so high as might be, because the scavenging ports are closed before the exhaust ports, so that compression starts from atmospheric pressure instead of from 3 to 6 lb. per sq.in., as is the case where scavenging valves are used.

Fig. 3 shows the system of scavenging used on an engine of the two-stroke-cycle type. The combustion chamber is not distorted and the scavenging ports are allowed to remain open for a short time after the exhaust ports have been closed. The main scavenging ports *A* are arranged half-way around the circumference of the cylinder at the bottom, opposite the exhaust ports *B*. Directly above the main scavenging ports *A* are the auxiliary scavenging ports *C*. The admission of air to these ports is controlled by the auxiliary scavenging valve *D*, which is operated by an eccentric on the engine camshaft. The scavenging ports are inclined so as to deflect the air upward and thoroughly scavenge the cylinder.

As the piston *E* nears the end of the power stroke it first uncovers the auxiliary scavenging ports *C*, but no air is admitted through these ports because the valve *D* remains closed. It then begins to uncover the

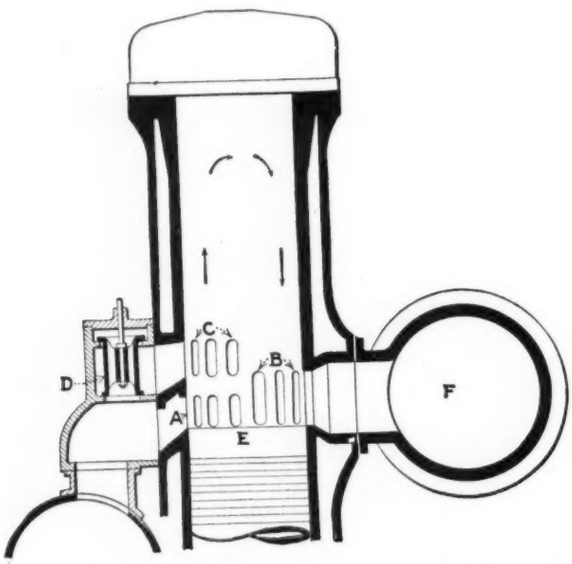


FIG. 3. SCAVENGING BY MAIN AND AUXILIARY PORTS

exhaust ports *B*, which allows the product of combustion to escape to the exhaust pipe *F*. When the piston has reached the end of the stroke, it has completely opened the exhaust ports *B* and also the scavenging ports *A*, thus allowing air to enter the cylinder from the receiver. At this time the valve *D* begins to open and admit air through the ports *C*. On the return stroke the piston first closes the main scavenging ports *A*, but by this time the valve *D* is wide open and air is still entering the cylinder through the ports *C*. Next, the exhaust ports *B* are closed, shortly after which the auxiliary scavenging ports *C* are closed. The valve *D* remains open until the ports *C* have been covered by the piston.

These three systems of scavenging are the ones generally used on two-stroke-cycle Diesel engines. There are a few other systems used, but they differ only in minor details from the ones described.

The air for scavenging is obtained from the scavenging pumps, which are of the low-pressure reciprocating

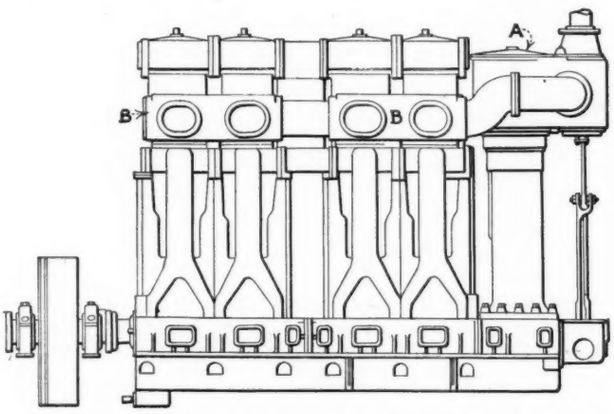


FIG. 4. ARRANGEMENT OF SCAVENGING PUMP AND AIR RECEIVER

type and have a large capacity. The pumps are usually driven by the main engine, either from the crankshaft or by means of levers and rods connected to the crossheads or connecting-rods. In marine work two pumps per engine are usually furnished, so that in case one breaks down the other will deliver enough air to keep the engine running, as each pump has about 60 per cent. of the total capacity required to run the engine.

The scavenging pumps discharge into a receiver, usually of small dimensions, which runs the whole length of the engine and supplies air to each cylinder for scavenging. This arrangement is shown in Fig. 4, in which *A* is the scavenging pump discharging into the receiver *B* which supplies air to the cylinders.

Very often large engines are divided into two sections; that is, a 4-cylinder engine is treated as two 2-cylinder engines and a 6-cylinder engine is treated as two 3-cylinder engines, one scavenging pump supplying each section. On very large double-acting engines one scavenging pump per cylinder is often used.

Fig. 5 shows a cross-section of a typical scavenging pump. The cylinder *A* is mounted on the engine frame and the piston *B* is driven by the beam *C*, which in turn is driven, through links, from the crosshead of the main engine. The air is drawn from the suction pipe *D*, through the suction valves *E*, into the cylinder *A*, and is discharged through the discharge valves *F* into the passage *G* which leads to the scavenging air receiver. The flat or grid valves commonly used in this type of pump are closed by their own weight or by light spiral springs. Air enters the suction pipe *D* through the vertical slots *H* in the cylinder *I*, which acts as a silencer and strainer.

In the designing of scavenging pumps, the most important point is the provision of an ample supply of air, but it is difficult to say what should be the exact capacity of the pumps relative to the working-cylinder volume. That it must be in excess of the latter is generally agreed. For ordinary marine engines and

low-speed stationary engines of the two-stroke-cycle type, the volume of the scavenging pump is frequently made 25 per cent. greater than that of the working cylinder, while in high-speed engines it is often made 50 per cent. greater.

Lately, turbo-blowers have been substituted for scavenging pumps in a number of cases. The results

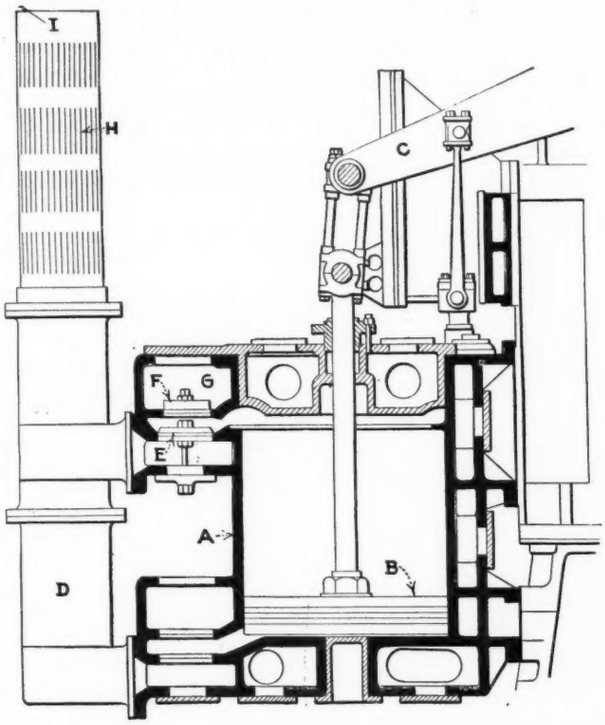


FIG. 5. CROSS-SECTION OF TYPICAL SCAVENGING PUMP

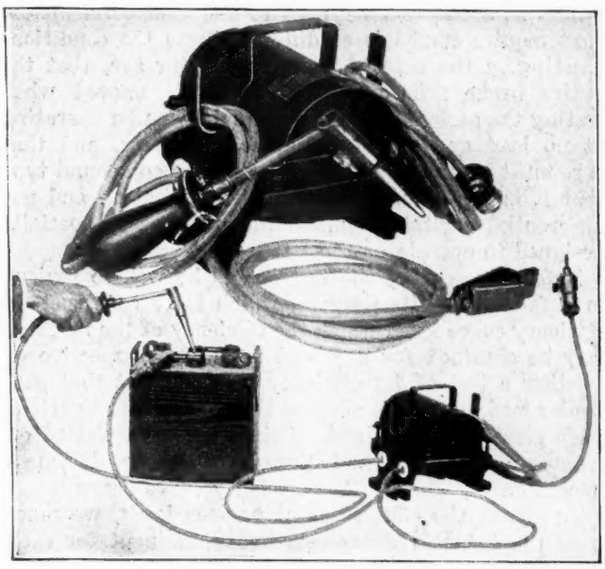
have been satisfactory, as a properly designed turbo-blower is capable of delivering a large volume of air at a pressure high enough for satisfactory scavenging, and it will undoubtedly be used extensively in the future, because of its simplicity and ease of regulation.

Lead-Burning Transformer for Small Storage Batteries

The most modern method of burning terminals in place on storage batteries, removing old connections, cutting off or building up posts, and in fact almost any form of lead work, is to do it by the electric-welding process. A lead-burning transformer, shown in the illustration, has recently been developed for small storage-battery work. This transformer is designed to be connected to the ordinary 110-volt alternating-current lamp socket, a 10-ft. cord with plug being provided for this purpose. Two separate rubber-covered terminal leads are used to convey the low-voltage heat-producing current to the parts of the battery to be welded. The lead having the "Big Brute" clip is for fastening to the battery plate or posts to be worked on; the other lead has at its end a carbon holder, which is arranged with a heavy insulated handle so that the operator's hand is guarded from the heat. The carbon holder takes an ordinary arc-welding carbon, this carbon forming the second terminal.

When the pointed arc-welding carbon is brought into contact with the lead, the pointed end becomes so hot that it melts the lead over a restricted area quicker than a pointed gas flame will do it. The welding or burning operation is carried out by a sort of puddling process, the carbon terminal being manipulated to flow the lead where needed.

One of the advantages of the appliance is that repair work in hard-to-get-at corners can be done more easily as the heat is always right at the point of the carbon. The device is readily portable, weighing approximately 25 lb. Joints do not have to be cleaned, as the dirt and slag automatically rise to the surface of the molten lead and the surfaces are joined while cleansed. When properly used, there is no glare to injure the operator's eyes, as he looks down on the cool end of the carbon in such a way that the bright point where the carbon touches the lead is hidden from view.



LEAD-BURNING TRANSFORMER ASSEMBLED AND IN USE

On the basis of 10c. per kilowatt-hour, it costs about 8c. an hour for current when the device is operating steadily. The instant the carbon point is removed from the work the current consumption practically ceases, as the device then takes only 4.5 watts from the line. The apparatus is especially valuable in reconstructing and repairing batteries, while in a shop and foundry it has been used where all kinds of odd soldering jobs must be done. It has also been found applicable in plumbing, roofing and tank building. This equipment is manufactured by the General Electric Co., Schenectady, N. Y.

A paste metal polish is made from the following ingredients, which are sufficient to make 20 lb. Take 4 lb. of cake tallow, 2 oz. of spermaceti, 10 star candles; 2½ pt. raw linseed oil; 2½ pt. kerosene and 5 lb. tripoli powder. Secure a three- or four-gallon crock, put in the tallow, spermaceti and candles and melt over a slow fire. Then add the linseed oil and kerosene and stir well. While this mixture is still warm remove from the fire and slowly add the tripoli powder, continually stirring the mixture. Then allow to cool and apply with a soft cloth. After drying it can be removed by going over the polished surface with a dry cloth. This polish is good for either hot or cold smooth surfaces.

The Electrical Study Course—Prony Brake Test on Electric Motor

Describes the details of an efficiency test as made by means of a prony brake and illustrates the method with a numerical example.

TO MAKE clear the application of the theory regarding brake tests, as it was developed in the preceding lessons, an outline will be presented of the details of such a test as it would be conducted in practice. The procedure for the three types of motors, shunt, series and compound, would be practically the same, and since the shunt type is the simplest, it will be selected as the one to use in the example. The only points in connection with series and compound motors that require emphasis as differing from the conditions existing in the case of the shunt motor are, that the entire brake friction must never be removed when testing the series type, since it would then be operating at no load and would therefore run away, and that care must be exercised when testing the compound type that it is connected for cumulative excitation and not differential excitation unless the machine is specially designed to operate as the latter type.

Before presenting the test it will be well to review, in a few words, its purpose, which is to construct an efficiency curve from which the efficiency of the machine may be obtained for any load upon it, irrespective of whether a test of its efficiency was made at that particular load. For this purpose the efficiencies at various loads must be determined. Points are then plotted on cross-section paper, and through them is drawn a smooth curve, which is the efficiency curve desired.

To obtain the efficiencies at various loads, we must know the output and the corresponding input for each

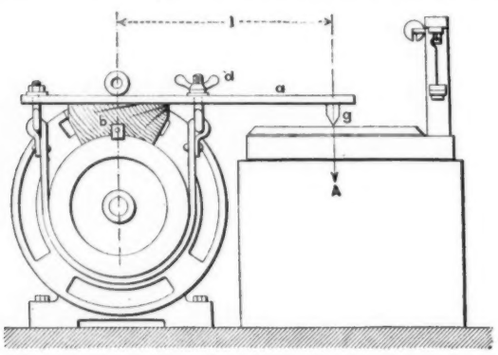


FIG. 1. MOTOR FITTED WITH A PRONY BRAKE

of the loads selected for testing, which are usually 25, 50, 75, 100 and 125 per cent. of the full-load current marked on the name-plate. The output is determined by means of the brake and the input by means of a voltmeter and an ammeter. Knowing the output and input for a given load, we can compute the corresponding efficiency, since

$$Efficiency = \frac{output}{input}$$

Assume that the motor to be tested is rated at 5 hp., 115 volts and 40 amperes and that it is to be tested by means of a prony brake such as that illustrated in Fig. 1; also that it has been fitted with a hollow pulley for water cooling. The first step would be to connect up the machine and instruments as shown in Fig. 2 and to start it, observing the direction of rotation, which should be such as to cause the brake to move downward; that is, in the direction *A* in Fig. 1. When it is found that the rotation is in the proper direction, the motor is stopped and the brake is adjusted to its pulley. The platform scale is then set under the contact edge *g* at such a height or a block of wood placed on the scale so

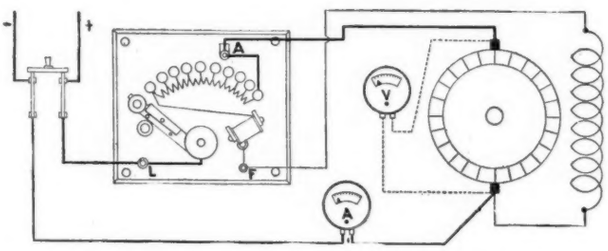


FIG. 2. SHUNT MOTOR CONNECTED TO STARTING BOX

that the arm *a* is level. The distance *l* is then measured if it is not already known. It is now necessary to find the weight recorded by the scale owing to the fact that it is supporting the brake at *g*. This weight plus the weight of the block of wood, if used, will have to be subtracted from the readings obtained when the pulley rotates, since it is merely the dead weight of the brake equipment and is not due to any force tending to push it in the direction *A*. It is understood that the reading must be taken while the nut *d* is slack. A more accurate method of determining the tare weight is to revolve the pulley slowly, first in one direction and then in the reverse, noting the reading of the scale in each case; the average of the two readings is the actual weight. The effect of any friction between the block *b* and the pulley, which might prevent the true weight from bearing on the scale, is thereby eliminated. A revolution counter or a tachometer will be required to measure the speed. Forms in which to record the readings should be prepared, after which everything would be in readiness to begin the test, which would be carried out as follows:

Start the motor and pour a moderate quantity of water into the pulley. Then tighten down on the brake nut *d* until the current as indicated by ammeter *A* reads about 50 amperes which is equivalent to 25 per cent. overload. Allow the motor to run under these conditions for about one-quarter to one-half hour in order that it may become warmed up and thus be operating under conditions as nearly duplicating those found in practice as possible. The water in the pulley will quickly be raised to the boiling point and a cloud of steam will be found to issue from the pulley. As the water boils away it should be replenished from time to time so that the pulley shall never run dry.

After the machine is thoroughly warmed, the readings are to be taken. There will be five sets of them; namely, for 25, 50, 75, 100 and 125 per cent. of full-load current; that is, for 10, 20, 30, 40 and 50 amperes, and each set will consist of a reading of the voltmeter, the

ammeter, the scale and the revolution counter. Therefore, to start, adjust the nut *d* of Fig. 1 until ammeter *A* of Fig. 2 indicates a current of 10 amperes, and make a record of all the readings. Then increase the tension until the ammeter indicates 20 amperes and again record the readings. Follow a like procedure for values of 30, 40 and 50 amperes.

When the last reading has been taken and the motor is ready to be shut down, loosen the nut *d* completely,

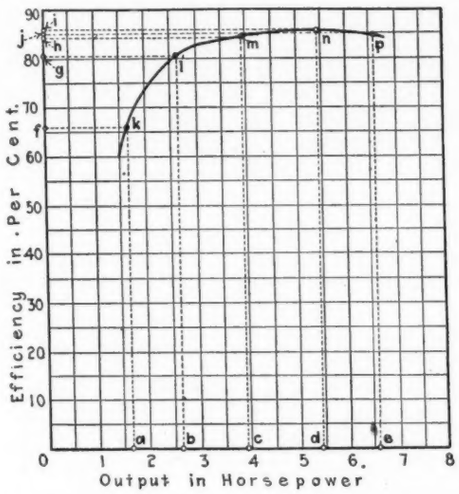


FIG. 3. MOTOR-EFFICIENCY CURVE

hold the pail directly under the pulley and pull the switch. As the pulley comes to a stop, the water is no longer kept against the inside face by centrifugal force, and it will splash out into the pail. If the motor is shut down while there is tension on the brake the armature will come to a sudden stop, with the result that the hot water in the pulley will be apt to be thrown out more or less violently.

Let us suppose that the length *l* was measured and found to be 15 in., that the tare weight of the brake is 2 lb. 3 oz., and that the five sets of readings gave the results given in Table I.

TABLE I. READINGS OBTAINED FROM MOTOR

Reading No.	Volts *E*	Amperes *I*	R.p.m. *S*	Lb. Oz. *W*
1	118.0	10.2	1630	4—15
2	117.4	20.4	1590	9—01
3	116.9	30.0	1545	13—00
4	116.2	40.1	1495	17—03
5	115.4	49.8	1440	21—05

The input in each case is watts $= EI$. To convert into horsepower we divide by 746, so that, Input in hp. $= \frac{EI}{746}$. If we let *S* represent the speed for a given load and *f* the corresponding force registered by the scale, we have that the output is equal to $2 \times \pi \times S \times f \times l$ ft.-lb. per min. Dividing by 33,000 will give us horsepower; that is, Output in hp. $= \frac{2 \times \pi \times S \times f \times l}{33{,}000}$. The values of π and *l* are the same for all cases, so that we may substitute them in the formula, thus giving us, Output in hp. $= \frac{2 \times 3.142 \times S \times f \times 15}{33{,}000 \times 12}$, where the 12 in the denominator is introduced to convert *l* from inches into feet. Simplifying the expression gives, Output in hp. $= 0.000238 \times S \times f$. The value of *f* is obtained by subtracting the tare weight of the brake (namely, 2 lb. 3 oz.) from the weight *W* appearing in the last column of Table I. We thus have that, Output in hp. $= 0.000238 \times S \times (W - 2$ lb. 3 oz.).

Upon making the computations for the input and output for each reading we obtain the results contained in the second and third columns of Table II.

TABLE II. MOTOR'S EFFICIENCY AT VARIOUS LOADS

Reading No.	Input, Hp.	Output, Hp.	Efficiency Per Cent.
1	1.614	1.067	66.11
2	3.210	2.602	81.06
3	4.701	3.976	84.58
4	6.247	5.337	85.43
5	7.704	6.550	85.02

In the last column are the corresponding efficiencies which are obtained by dividing the values in column 3 by those in column 2; that is, by dividing the inputs into the outputs. The values so obtained are multiplied by 100 to convert them into per cent.

Having the efficiencies corresponding to various outputs, we are in a position to construct the efficiency curve. Taking a piece of graph paper, lay off upon it a horizontal scale representing horsepower, from the zero point of which start a vertical scale representing efficiency in per cent. Then we locate the value of the horsepower output for each reading on the horizontal scale and similarly the value of each efficiency on the vertical scale. Thus, in Fig. 3 *a* is pointed off at 1.067 hp., *b* at 2.602 hp., etc.; likewise *f* is pointed off at 66.11 per cent., *g* at 81.06 per cent., and so on. Then an imaginary line is traced upward from *a* until it meets an imaginary line traced horizontally from *f*, their intersection at *k* being one point of the curve. In the same manner *l* is the intersection of *b* and *g*,

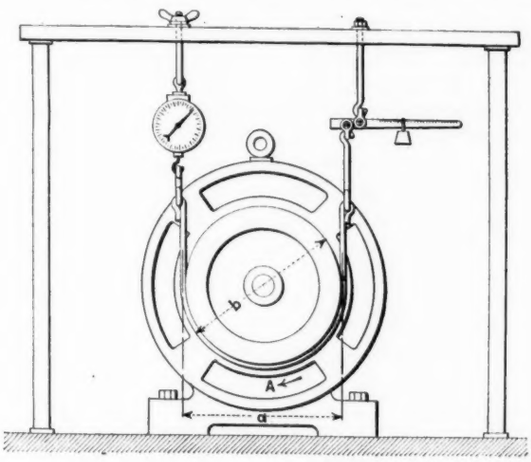


FIG. 4. BRAKE USING TWO SCALES

m of *c* and *h*, etc. Having located the points *k*, *l*, *m*, *n* and *p*, the curve is drawn through them.

When the form of brake used is one using two scales, such as that shown in Fig. 4, the method of testing remains the same with the exception that two scales must be read for each load and that the diameter of the pulley is measured instead of the length of brake arm. Attention is to be called to the fact that the actual effective diameter is really the distance from center to center of belt as shown by *a*, and not the diameter of the pulley itself. The most convenient way to determine this effective diameter is to measure the distance from the pulley face to the outside of the belt on the opposite side, as indicated by *b*. The power output for each load would then be equal to $\pi \times D \times S \times (W_1 - W_2)$ in which *D* represents the effective diameter in feet, *S* the speed in r.p.m. and W_1 and

W_2 the pulls in pounds registered by the beam scale and the spring balance respectively. It is understood that the direction of rotation would have to be as indicated by the arrow *A*.

The problem of the preceding lesson dealt with a prony-brake test such as that illustrated in Fig. 1. It was stated that when the force acting on the scale platform is 17 lb. the speed of the motor is 1500 r.p.m., and it was required to find what horsepower the machine is delivering under these conditions if the length of the arm is 20 in. In the solution of this problem we can use the formula applied in the present lesson to the assumed brake test; namely, Output in hp. $= \frac{2 \times \pi \times S \times f \times l}{33{,}000}$. This will give us, Output in hp. $= \frac{2 \times 3.142 \times 1500 \times 17 \times 20}{33{,}000 \times 12} = 8.09$.

Upon testing a motor by means of a brake such as that illustrated in Fig. 4, readings were obtained as given in Table III.

TABLE III. DATA OBTAINED FROM MOTOR UNDER TEST

Reading No.	*E* Volts	*I* Amperes	*S* R.p.m.	W_1 Lb.Oz.	W_2 Lb. Oz.
1	110	12.5	1200	24–06	10–05
2	110	25.0	1150	58–15	19–12
3	110	37.5	1100	92–11	27–07
4	110	50.0	1050	117–14	35–14
5	110	62.5	1000	162–15	43–10

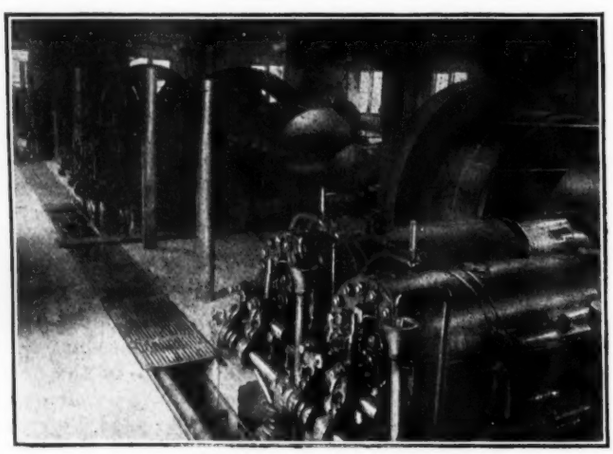
The effective pulley diameter is 8½ in. Construct the efficiency curve of the motor.

Pumping Oil Wells by Electricity

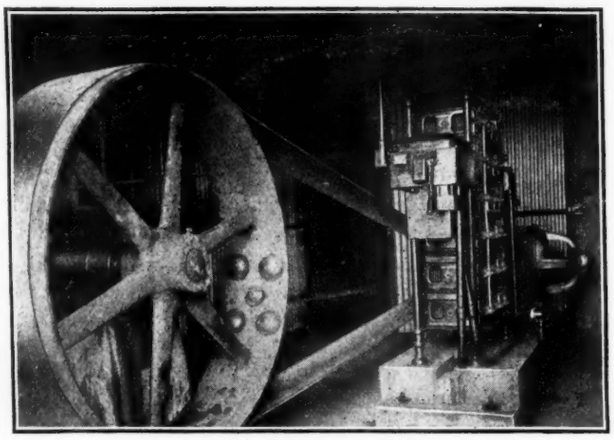
BY O. H. NONNENBRUCH

Steam power is still universally used for cable drilling of oil wells. Efforts to introduce more efficient prime movers have been made, but a change has not been brought about. After oil has been struck, it is usually necessary to pump the well to obtain the oil; this requires a comparatively small prime mover. Occasionally it is necessary, in order to inspect or repair the pumping equipment, to pull up the rods and tubing. In this case additional power is needed.

In the earlier days the steam engine and boiler that furnished the power for drilling the well were also used for pumping. This is a very wasteful method and results in an average fuel consumption of about ten barrels in twenty-four hours, an extremely high consumption for an output of less than ten horsepower. Subsequently, it became common practice to remove the steam engine and substitute a gas or oil engine after the well had begun



VIEW OF ENGINE ROOM



INSIDE THE MOTOR HOUSE

to produce. This method resulted in a considerable reduction in fuel consumption, but still has its disadvantages, as the gas or oil engines distributed over a wide area require much attention. Besides this the fuel consumption is still comparatively high, because power units are small and not of a type that allows the best economy.

The latest method of production is to install at each well an electric motor. This permits centralization in the production of the current and offers possibilities for the highest economy, and the amount of attention required at the wells is reduced to a minimum. The power for operating the electric motors may be carried to the lease and from there to the various motors over transmission lines, or it may be developed in a central power plant located on the field. A typical example of this method is found on the Page-Lewis lease, near El Dorado, Kan.,which is operated by the Magnolia Petroleum Co. The power plant contains four De La Vergne twin-cylinder Diesel engines, rated 360 hp. per unit. Each engine is belted to a 300-kv.-a. alternating-current generator, delivering current to the busbars at 2300 volts. The generators all operate in parallel on a 60-cycle three-phase circuit, and the current is transmitted to transformers located centrally with respect to each six wells, where it is stepped down to 440 volts. When operating the pumps, the motors develop up to 15 hp. at 550 r.p.m., and when used for pulling rods and tubing they are capable of developing up to 30 hp. at 1100 r.p.m. A pole-changing switch connects the different windings. The motors are reversible and equipped with controllers for speed regulation. They are belted to jackshafts and from there to the band wheels, which in turn operate the walking beams through pitman or wooden connecting-rods.

At present about 50 wells are operated from the central power house. The total fuel consumption is less than fourteen barrels of oil per twenty-four hours. This covers pumping, rod and tubing pulling for all the wells, electric lighting of the lease and power for a machine shop, as well as pumping of crude oil to pipe lines within the lease.

During the blizzard in January, 1919, when the Kansas fields were covered with snow and the temperature was below zero for several days, the electrically driven wells continued to operate without a shutdown or special attention. In neighboring fields gas-engine operated wells had to shut down for over a week owing to frozen gas pipes, etc., while others were kept going only by continuous and extraordinary efforts.

EDITORIALS

Why Does the Water in a Boiler Lift When the Safety Valve Blows?

THE Boiler Code Committee of the American Society of Mechanical Engineers recently gave a hearing to a delegation of manufacturers of safety valves. The 1914 edition of the Code limited the lift of a safety valve to fifteen one-hundredths of an inch irrespective of its diameter, and also limited the size to four and a half inches. Both of these restrictions have been removed in the latest edition of the Code, and the manufacturers came to remonstrate and to talk it over. One of the principal arguments presented against high lifts and large diameters was the lifting of the water said to occur with the sudden opening of a large aperture. A visualization of just what does occur under such circumstances would be helpful in determining to what extent such restrictions are advisable and how they should be applied.

What lifts the water from the level of the water line and throws it out of the safety valve?

When the valve opens, the steam rushes out at a rate proportionate to its absolute pressure. In order that there may be a flow of steam from the other parts of the boiler rapid enough to replace that which passes out of the safety valve, there must be a diminution of pressure in the area immediately below the valve. How great this difference in pressure must be depends upon the velocity with which the steam rushes toward the safety-valve opening, and this depends upon the shape and cross-sectional area of the steam space.

When the boiler is steaming, there is no definite water level. The surface is tossing and heaving with the disengagement of steam bubbles. This disengagement will be very active for the first instant that the pressure upon the surface of boiling water is reduced, and may be so active right under the valve as to throw up a column of water which, aided by the sweeping action of the steam rushing to the opening with the velocity of a cyclone, is carried out of the boiler. Knowledge of how waterspouts are formed and the conditions essential to their production and maintenance would be useful in this connection. Tales of cases in which the water continued to be discharged until the boiler was emptied are probably "grossly exaggerated."

The lifting action can be avoided by a gradual opening of the valve. "Gradual" is used in a comparative sense, for a valve may even *pop* more or less abruptly, and there may be a material difference in the behavior of a mass of water if the large opening is made all at once, liberating steam instantly and generously, or if the opening comes a little more gradually and allows of the less tempestuous release of the excess heat at the lowered pressure. It is for this reason that the A.S.M.E. Code says that "safety valves may be used which give any opening up to the full discharged capacity of the area of the opening at the base of the valve, provided the movement of the valve is gradual so as not to induce lifting of water in the boiler."

From this point of view and as far as lifting of the water is concerned, it appears to be a question more of timing operation than of lift. A certain safety-valve area is required to discharge the maximum amount of steam that a boiler can make. This area may be had with a valve of small lift and large diameter or one of large lift and correspondingly smaller diameter. The smaller valve with its lesser edge opening does not necessarily give the more sudden release.

Who knows what happens in a boiler when the safety valve lifts? We suggest it as a subject for thought, study and discussion. Our correspondence columns are open for contributions concerning it.

The Importance of Checking Electrical Instruments

CAREFUL checking and inspection of electrical instruments rarely receives the attention and consideration its importance warrants. The operation and control of electric machinery and apparatus is largely automatic. The functioning is shown by the indications of switchboard or other types of instruments. It is from the indications of electrical measuring instruments that loads are served, machines started and stopped—in fact, by which everything having to do with the safety of apparatus and its performance are judged. Yet these important, vital pieces of apparatus do not usually receive nearly the care they should.

The importance of careful synchronizing was emphasized by Mr. Gillooly in the April 29 issue. He told of what had happened when mistakes in synchronizing, due to faulty synchronoscopes, or otherwise had occurred. The trouble is that too few station attendants inspect their instruments often or carefully enough—letting well enough alone apparently.

That operating difficulties, damage to apparatus and derangement to service may occur when a synchronoscope is defective or functions wrongly is fairly obvious. So also when a voltmeter gives a wrong indication. However, some instruments might appear to play a less important part in safeguarding service and machines, as for instance the power-factor meter. This instrument has nothing to do with synchronizing or paralleling machines. It plays no part in the load distribution between alternating current machines, since the load distribution is a matter of energy input to the prime movers, which may be controlled by the governor's action. However, power-factor does depend upon terminal voltage, and therefore determines the wattless or magnetizing current that circulates between units connected in parallel. This circulating current does no useful work, but only reduces the capacity of equipment. Operating troubles caused by an inoperative power-factor meter, given by W. H. DeMuth, on page 985 of this issue emphasizes the importance of checking up instrument performance regularly and of the operator being at all times thoroughly familiar with his switchboard instruments.

The Electrical Study Course

FOR two and one-half years "The Electrical Study Course" has been published in *Power*. During this period the seventy-four lessons given have treated of direct-current apparatus almost exclusively, and if the contents of numerous letters sent in commenting on the course are any indication, it has filled a long-felt need. Beginning with the issue of July first and continuing for the rest of the year, alternating current and alternating-current apparatus will be given consideration. As has been done with the direct-current lessons, every effort will be made to present the coming lessons so that they can be easily understood by those with a limited knowledge of mathematics, electricity and magnetism.

The importance of the study of alternating current cannot be overemphasized, especially at this time, when its use is increasing so rapidly for most every conceivable purpose except electrolytic work, and even here in many cases the power is transmitted to where it is to be used as alternating current. Applications that until recently could be satisfactorily met only by the use of direct current are now being successfully done with alternating current, and the end is not yet. Therefore it behooves every operating engineer and electrician to familiarize himself with the fundamental principles of alternating-current apparatus, whether he has such machinery in charge at the present time or not, for the prospects are he may have at some future time.

The idea is all too prevalent that the subject of alternating current is difficult and complicated and can be understood only by highly trained technical men. This may be true of certain branches of the study, but it certainly cannot be said in regard to alternating-current power equipment, for in almost every case it is more simple in its construction than direct-current apparatus, and its operation can be understood easily by anyone who can understand the operation of direct-current apparatus. Anyone who can understand the operation of a direct-current generator can easily understand the operation of an alternator, since the direct-current machine is nothing more nor less than an alternating-current machine with the added complication of a commutator. If the readers of *Power* who are not familiar with the subject of alternating current will just forget that it is complicated and give conscientious study to the lessons that will appear during the next six months, they will find that the awe-inspiring features of the study were mostly imagination.

Articles on Refrigeration

WHEN the prohibition scare first hit some of the beer and liquor industries many years ago, builders of refrigerating machinery wondered how long it would be before the closing of breweries would also close their shops because of lack of business. Today prohibition is here, and the closing of breweries causes but a ripple on the growing sea of refrigerating business. Such is the growth of the industry. And the application of refrigeration to the industrial arts has but begun despite its varied use.

Refrigerating engineers who design and remodel plants can tell of almost unbelievable operating conditions found in refrigerating plants, large and small. These conditions are not confined to any particular section of the country; they are found all over the continent. And why? Well, the causes are numerous, but one of the chief reasons is inexperienced operating refrigerating engineers, many if not most of whom are not to be too severely criticized for their lack of knowledge and skill in refrigeration.

In the first place most owners of refrigerating plants, in putting men in charge of their equipment, seem to regard the question of whether these men are refrigerating engineers as secondary. There are not many thoroughly competent operating engineers in the refrigerating industry, and unless a man has been fortunate enough to work with one or more of these few, his training is likely to have been deficient. If so, he turns in vain for books that tell him and show him the how of things he needs to understand. A useful book for the operating refrigerating engineer never has been put on the market and likely never has been written.

The operators themselves must write for their fellow operators. The man with experience, the man who knows the principles of operation, who knows when equipment is inadequate for load demands, who can diagnose trouble and correct it, who can "make it go" in the face of adverse circumstance and when others fail, who can produce a ton of refrigeration or of ice with the highest practicable efficiency and at the lowest cost—this man is the fellow to whom his brother engineers must look for guidance, opinions and advice. It is to him that owners and builders must turn if their machines are to be well operated.

This is the man we are looking for. We have several whose articles are a boon to men in the field. We want more of the same kind—men who can tell "how to do it," not preachers of sermons.

If you are one of these, or if you think you are, if you feel that you have something of interest and value to say to others, let us have it. It is what you say that counts; not how you say it. We take care of the how. And it pays well, too—sentimentally and substantially.

Every steam engineer has his difficulties in power-plant operation, but judging from the pay some receive in comparison with the remuneration of other skilled employees, it would seem that the managements consider his position something akin to the everyday office boy; that he is a necessary evil of not much account, but something that cannot very well be elimi nated.

The perpetual-motion crank is the Bolshevist of the mechanical world, for he firmly believes that he can produce unlimited comforts and necessities without personal exertion.

It is dangerous to stand on the arch of a dutch-oven furnace. It may fail under the weight and result in the workmen falling into the flames.

Many boilers have been made to give better evaporative results by changing the baffling. Have you tried it?

When men are working in an empty boiler, it is a good idea to lock all valves closed connecting to it.

A clean water glass is necessary to safety.

Correspondence

Inoperative Power-Factor Meter Caused Shutdown

In the Apr. 29 issue of *Power* Frank J. Gillooly, in an article entitled, "Don't Take Chances With the Synchronoscope," drew attention to the importance of being careful in synchronizing and checking up the synchronoscope. However, the synchronism indicator is not the only instrument that may cause trouble in the operation of electrical machinery; the fact of the matter is that most any of the switchboard instruments may do so under certain conditions—even the power-factor meter, as will be seen from the following:

A 2000-kw. frequency changer was used for transferring energy from a 60-cycle to a 25-cycle system and vice versa. A 1000-kw. set was also operated in the same station. The smaller frequency changer was operating and an increased load upon the 60-cycle system made it necessary to parallel the 2000-kw. unit, running the two units together upon a common busbar. The station attendant paralleled the machines and then began to adjust the field excitation of the synchronous motor on the 25-cycle end and of the generator on the 60-cycle end so as to bring the power factors up to normal.

The power factors of the synchronous motors were usually maintained around unity or 98 per cent. leading, to help out the system, whereas the power factors of the 60-cycle generators depended upon the power factor of the load and the excitation of the individual machines. At the time of paralleling the station load was heavy and the attendant tried to adjust the motor's power-factor of the large frequency-changer for unity. After the adjustment of the motor's and generator's field had gone on for some time, with the 60-cycle load rapidly increasing, the attendant discovered that he was unable to make the 1000-kw. generator pick up its proper share of the load, or bring the power factor of the 2000-kw. machine up to the same value as that of the smaller machine. In fact, he found that all adjustments of the field rheostats of all the machines had made no effect whatsoever upon the power factor of the 2000-kw. generator.

He thought that perhaps he had paralleled the two motor-generator sets wrongly, so that proper load division was impossible, but realized that the load was too heavy to cut out the smaller machine with a view to synchronizing them again. Just about this time the 25-cycle oil switch controlling the 2000-kw. synchronous motor of the large frequency-changer set opened, shutting down this machine. The 2000-kw. load was immediately picked up by the 1000-kw. machine in addition to its own load, and this unit shut down, causing a complete interruption of service.

The whole trouble was caused by the power-factor meter of the 2000-kw. 60-cycle generator not working, because the fuse in the transformer supplying it had blown. From the time this set was started to the time it shut itself down, the power-factor meter's pointer had not moved. The shutdown was caused by the excessive overload on the motor, necessitated by the overexcitation of its field in the endeavor of the operator to maintain normal power factor when the meter was not working. If the operator had had a proper understanding of his equipment, he would have noticed very soon that the power-factor meter was not responding to rheostat adjustment and found that the load distribution was not normal. The doctrine of checking instruments should be preached often and loud.

Chicago, Ill. W. H. DEMUTH.

Why a Centrifugal Pump Failed To Feed Boilers

I had an experience with a pair of three-stage centrifugal boiler-feed pumps, which may be of interest and help. Each pump had a capacity of 1000 gal. per min. and was steam-driven and connected in parallel between the supply main from the open heaters and the boiler-feed water line, with a gate valve in both suction and discharge and a check valve in the discharge line of each pump. The pumps furnished feed water to water-tube boilers of about 6000 hp. capacity working on a 24-hour service operating alternately one week at a time.

Every Saturday afternoon one pump is shut down, the bearings, governor and pressure regulator inspected and cleaned, and then left with suction and discharge valves open ready to be started at a minute's notice.

On this particular day No. 1 pump was started and appeared to be operating all right, but as soon as the throttle was closed on No. 2 pump the pressure began to drop and No. 2 had to be put in service again to keep the water in the boilers.

The governor and pressure regulator were carefully inspected and another trial gave no better results. As the pump had operated satisfactorily when it was shut down the previous week and had not been started in the meantime, we could see no reason why it should not pump. The chief was called, and after witnessing a trial and testing the speed, he ordered the machine dismantled and a thorough inspection made of the impellers, diffusers and shaft bushings. After everything was found to be all right and another trial made, he had the suction and discharge pipes removed and examined for obstructions. Everything was found in proper condition, but still the pump would not feed the boilers.

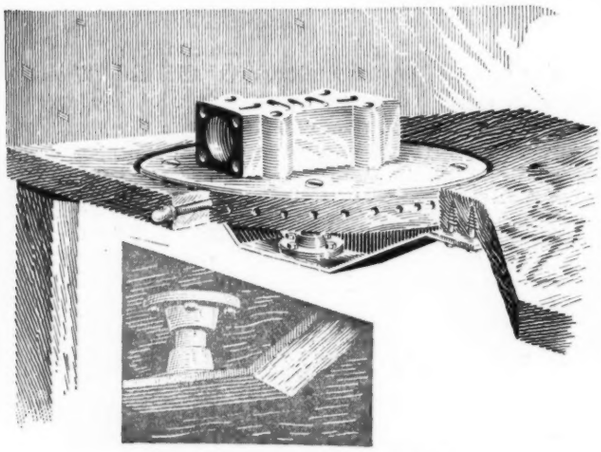
It was then about 8 p.m. Sunday, and the men were at the end of their rope. Since the load was very light at this time, No. 2 pump was stopped to see if No. 1 would pick up the pressure after a few minutes; but instead of stopping, No. 2 pump started to run back after the throttle was closed.

This showed conclusively that the discharge check valve on No. 2 was the cause of all the trouble, for as soon as its speed dropped sufficiently, No. 1 pump had bypassed its water through the other and thus could not keep up the pressure. ERNEST K. MANNING.

Watertown, Conn.

Workbench Turntable

A simple but useful device that I have adopted for handling heavy castings or machinery parts while doing bench work is a revolving table set in the bench flush with the top. It is easily made from two large-sized



REVOLVING BENCH TABLE

pipe flanges, a nipple and a couple of suitable hangers made of ½ x 1 in. flat stock.

The top of the turntable plank is covered with a piece of ⅛- or ¼-in. plate steel. The idea is conveyed in the accompanying sketches. A locking pin is used to hold the table in any desired position.

Concord, N. H. C. H. WILLEY.

Feed-Water Check-Valve Failure

In the May 6 issue of *Power*, page 698, R. J. Fox, in explaining the cause of a boiler being burnt, makes some statements with which I do not agree. For instance, he states that an automatic stop valve closed and cut a leaking boiler off the line, and further, that the faster the fireman ran his pump the faster the water fell in the gage-glass, and that the water rose in the other boilers owing to the siphoning action from the damaged one.

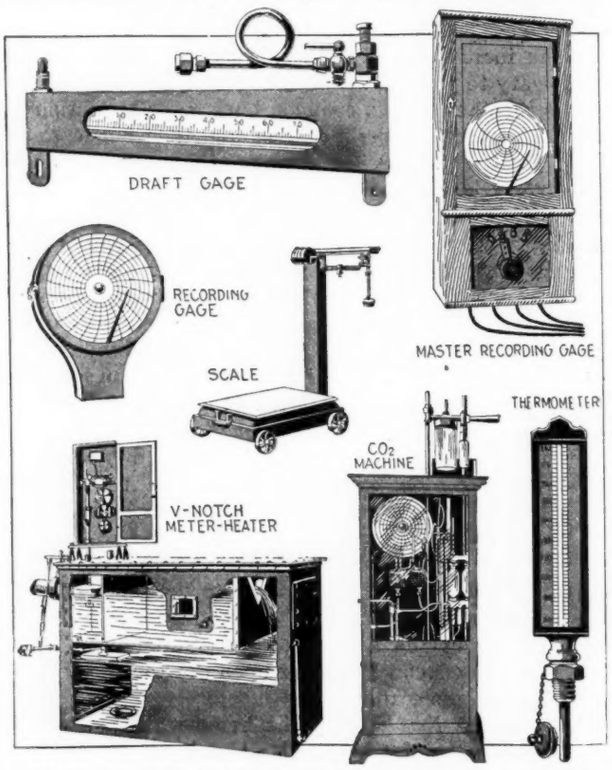
When the automatic valve closed on the damaged boiler, it showed that the pressure on that boiler had been reduced below that of the other boilers on the line. Therefore there could be no siphoning of water from the boiler with lower pressure to those of higher pressure. According to my way of reasoning the action would be just the reverse. As the water would take the path of the least resistance, it would naturally flow to the boiler with the lower pressure, and the automatic valve closing on the damaged boiler proves that the pressure was reduced. There could be no such thing as the water siphoning from the lower pressure to the higher pressure on the other boilers on that line. I would like to have others express opinions regarding that burnt boiler. M. H. HARRINGTON.

Fall River, Mass.

Economical Operation of Boiler Plants

The United States Fuel Administration during its operation insisted that every boiler plant in the country be operated with the utmost economy as regards fuel and oil consumption; further that suitable apparatus be installed to make possible and attainable economic operation. Without doubt the majority of boiler plants throughout the land complied with the suggestions of the Fuel Administration, and a world of good was accomplished, also many thousand tons of coal was saved. In view of these results it is surprising that when the Government builds boiler plants no attention is paid to the economic operation and generally no apparatus is installed to enable the engineer in charge to control his plant economically.

During the last few months I have had opportunity for personal observations along these lines. One of the many cases observed is that of a permanent hospital which has been built for the army, in which high-grade water-tube boilers with chain-grate stokers have been installed. The capacity of the present installation is 1600 hp. with room for 800 hp. additional. These boilers operate under a pressure of about 100 lb. and are used for generating steam for heating the buildings and also for cooking in the various kitchens. In short the plant is up-to-date in every particular except that there are no provisions made for the determination of draft, flue-gas composition, amount and temperature of feed water; nor are there recording pressure gages. There is not even a pair of platform scales to weigh the coal used. Several requests have been made for



SOME OF THE INSTRUMENTS THAT WERE MISSING

the purchase and installation of the apparatus needed, but these requests have been turned down or ignored. From this it is readily seen that no one could operate the plant economically. This plant is under the supervision of a regular army man who is blissfully ignorant of the proper operation of boilers and their accessories.

Several other similar incidents might be cited; but why go further? The fact remains that it seems quite proper for the Government-owned plants to be operated as efficiently as present-day science can make them, yet one runs against this state of affairs constantly in Government work. A. F. LAWLER.

Denver, Col.

Use the Broken Firebrick

It seems to me that it would pay some manufacturer of crushers and grinders to bring out a portable combined crusher and grinder with a mixer similar to a concrete mixer, to grind up firebrick, which is usually thrown away when making repairs to boiler brickwork.

Ground firebrick mixed with just enough fireclay to form a binder, together with a small amount of asbestos, makes an excellent cement for patching baffles, arches, door arches and side walls. I have used the mixture for these purposes to good advantage, and to say it saved my employers considerable in brickwork maintenance would be putting it mildly.

The mixture is as follows: Ground firebrick, 4 parts; fireclay, 1 part; asbestos, 1 part. It is mixed with a saturated solution of salt water. The firebrick should not be ground too fine. The less fireclay and asbestos used the longer the work will stand, and it is better adapted to withstand high temperatures. The mixture should be mixed one day and used the next; in other words, it should be mixed at least twelve hours before it is used.

Broken pipe covering and lagging can be utilized in this way. The asbestos makes the compound more ductile or workable, and it will stay put better. The mixture should not be too wet, but just moist enough to amalgamate with another body.

Many medium-sized and large plants could save thousands of dollars annually in the cost of labor and firebrick for repairs or alterations to boiler furnaces if such a mixture were available. Savings also result from its use for temporary repairs, as it frequently happens that firebrick linings give way unexpectedly in spots. As continued operation would ruin the common brick wall, it is necessary to take the boiler off. If brickmasons are called it may take two or three days to make the necessary repairs, whereas if the mixture is used the boiler can be in on the line in twelve hours' time, permanent repairs being deferred until a more opportune time. WALDO WEAVER.

Franklin, Ohio.

Synchronous Motor Would Not Start

The electrical equipment of a large mill included several synchronous motors, one of which had been so badly damaged by fire and water that rewinding was necessary. A complete set of coils was available and the rewinding was done by local repairmen. After completing the job, however, connecting the motor to its source of power failed to turn the rotor, although it had started very promptly before being damaged. Higher compensator taps were tried, but to no avail. An expert alternator winder was called from the factory and found that one pole-phase group of coils had been reversed as at *X*, Fig. 1. The interchanging of the leads of this group, as in Fig. 2, restored normal starting torque. It will be noticed that by tracing each phase through to the star connection in Fig. 2, the arrows point in opposite directions on adjacent pole-phase groups, which is the correct condition. In Fig. 1 the wrong connection is indicated by three adjacent arrows pointing in the same direction.

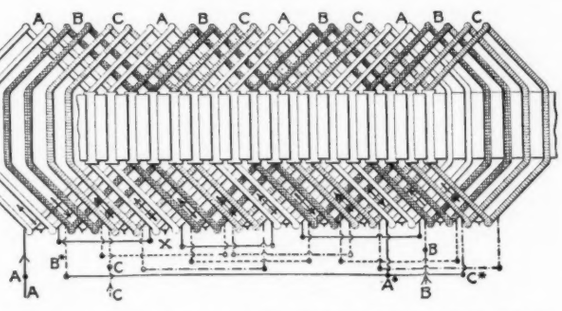


FIG. 1. POLE-PHASE GROUP SHOWN REVERSED AT X

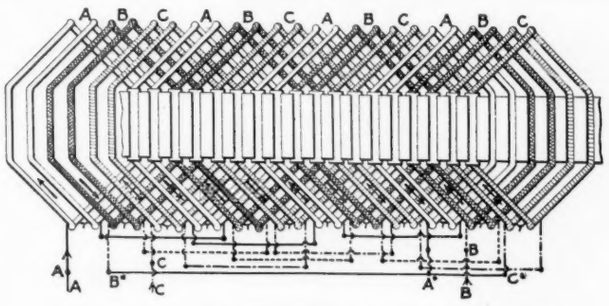


FIG. 2. CORRECT CONNECTION FOR A FOUR-POLE SERIES-STAR WINDING

The existence of such a condition may be proved by connecting ammeters into each phase conductor and observing the intake currents while the rotor is turned by hand; a reversed pole-phase group of coils will greatly unbalance the currents of the three wires. It is essential that the rotor be rotated so as to equalize impedance differences due to different phases including different amounts of iron in their magnetic circuits.

Brooklyn, N. Y. E. C. PARHAM.

Trouble With Scored Fuel-Valve Seat

The condition described by D. L. Fagnan in *Power* of Apr. 15 exists in too many Diesel plants. One is quite safe in stating that 25 per cent. of Diesel installations are troubled with leaky fuel valves. This condition, if allowed to exist, is blameable on the operating engineer.

Mr. Fagnan's method of detecting a scored fuel-valve seat is one that cannot be used in all cases. In many instances a valve will leak the high-pressure air when the groove that is causing the trouble can hardly be detected with the eye after the valve seat is removed. It is apparent that in such cases these minute grooves will not show on a wooden stick, no matter how highly polished the stick may be. Furthermore, most of the leaks are due to the minute pits that form on the narrow ground seat, this being seldom more than $\frac{1}{64}$ in. in width. These pits are below the general surface of the seat, and in no case will they show with the "stick-method."

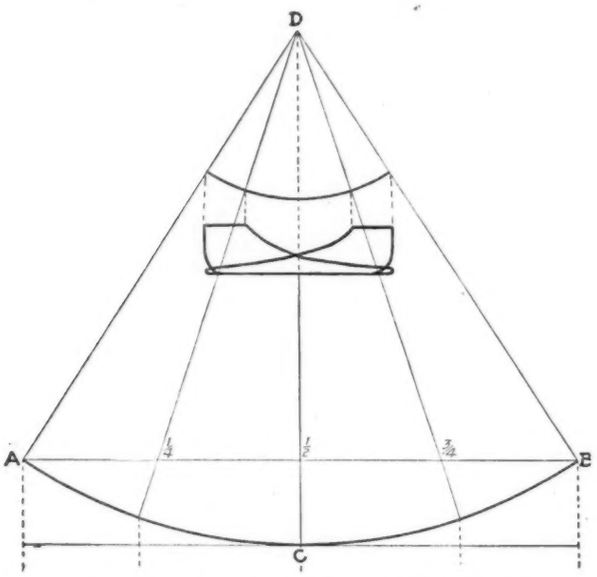
To detect a leaky fuel valve the injection air should be turned on and either the suction or the exhaust valve and cage removed. By reaching through this opening and placing the hand against the atomizer or fuel tip disk, the air will be felt blowing through the fuel valve. Then if the valve continues to leak after the needle valve has been reground, it is evident that the valve seat is in bad shape and should be reamed.

In doing the reaming if extreme care is not used the reamer will cause chatter marks, which, of course, will make conditions worse. E. E. SNOW.

Philadelphia, Penn.

Altering a Reducing Motion

After reading the letter on page 539 of the Apr. 8 issue of *Power*, by M. J. Merrell, concerning altering a reducing motion, I wonder if it has occurred to him that it is impossible to get a correct card with that kind of a reducing motion because, as the crosshead moves from



SHOWING DIFFERENCE IN LEVER LENGTH

one end toward half stroke, the pin finds a higher position in the slotted end of the lever; or, in other words, it pushes on a shorter lever at midstroke than it does at the ends of the stroke. This causes the diagram to stretch some in the middle and to bunch nearer the ends. Of course, figures obtained from such an incorrect diagram are also incorrect.

The accompanying sketch clearly shows this condition, and a little study and thought should convince anyone that this kind of reducer should not be used if accurate figures are expected. The straight line *AB* represents the crosshead travel, which is divided into four equal parts representing quarter stroke, half stroke, etc. The radii passing through these points from the pivot point *D* represent the pendulum at these points of the stroke. It will be noticed that at half stroke the arc, or curved line, *A C B*, which is the line of travel of the point of contact with the crosshead pin at the ends of the stroke, is quite a distance below the straight line, showing a much shorter lever transmitting the motion at this point than at quarter stroke and at the ends of the stroke. The insert diagram shows that the distance from one end to the quarter stroke is shorter than from the quarter to half stroke. The perpendicular dotted lines at the bottom show these same points on a larger scale.

FRANK AVIS.

Verde, Ariz.

Live Versus Exhaust Steam for Heating

I have read many articles on the subject of live versus exhaust steam for heating purposes, and a large percentage of the writers claim that no more or even less coal is burned with engines running and carrying a load and using the exhaust steam for heating than with the engines stopped and using live steam.

I cannot dispute this statement, neither can I deny that others are getting the results they claim. In the plant of which I have charge direct-connected steam engines are used. The exhaust steam passes through the boiler feed-water heater, the surplus going into the heating mains in the winter and through a domestic water heater during the summer months.

On dark or cloudy winter days the engines are run so that the lamps can be used by day as well as by night. On clear days the engines are shut down during the bright hours and a reducing valve allows live steam to enter the heating mains.

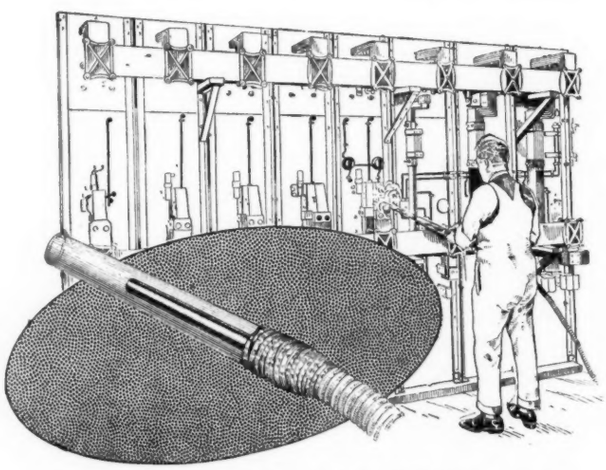
Our 24-hour consumption of boiler water in the winter is from 300,000 to 400,000 lb., and the pressure on the heating system seldom reaches and never exceeds 5 lb. gage. On days when engines are used for the full 24 hours the coal consumption for the hours the engines are running is from 5 to 10 per cent. greater than when they are idle. All exhaust steam and practically all condensate from the water heaters and other fixtures throughout the plant are used both in summer and in winter.

There is no blowing of one into the atmosphere and of the other to the sewer as is sometimes done. I fail to burn less coal with the engines working than when they are idle. I am open to conviction, however, and would be delighted to learn why I am using more fuel with my engines running, while others are using less.

Kingston, Ont., Canada. JAMES E. NOBLE.

Safe Switchboard Blower

It is risky to blow down the back of a switchboard with an air hose and the usual metal nozzle, for no matter how careful the attendant may be contact is



SWITCHBOARD BLOWER AND ITS APPLICATION

likely to be made with a live connection, especially when busses run along the back of the board. By placing a piece of water-gage glass over the nozzle as far as it will go, as shown in the insert illustration, and having the end of the glass tube beyond the end of the nozzle about two inches, the danger is eliminated.

The glass is secured to the hose by wrapping with adhesive tape. W. H. WATSON.

Norristown, Penn.

A liquid metal polish for cold smooth surfaces, either iron or brass, can be made by adding 2 oz. of oxalic acid and 1½ lb. of silicate powder to 3 parts of benzine. Keep in a bottle tightly corked and shake well before using.

Inquiries of General Interest

Heating Surface for Feed Water Heater—How many square feet of heating surface should there be in a closed exhaust-steam feed-water heater, receiving the exhaust of a 13 x 14-in. engine that is used for driving a 75-kw. generator? J. H. G.

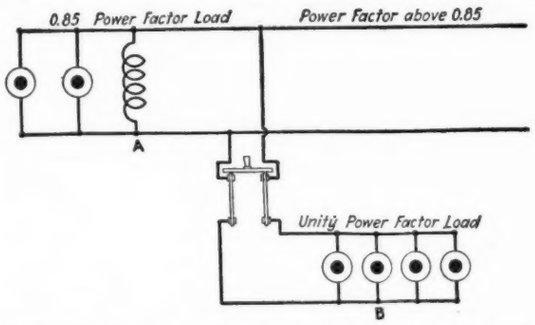
Allowing 90 per cent. efficiency of generator, 85 per cent. mechanical efficiency of the engine and 30 lb. of water per hp.-hour, development of 75 kw. would require about $75 \div (0.746 \times 0.9 \times 0.85) = 131$ boiler hp. For raising the temperature of the feed water from 60 deg. F. to about 204 deg. F., there should be not less than ½ sq. ft. of feed water heating surface per boiler hp., and for operation of the generator to full capacity, the heater should have not less than 65.5 sq. ft. of heating surface.

Determining Working Pressure of Boiler—How should the working pressure be determined for a boiler that has a crack in the shell? W. N.

A boiler that has a cracked shell should not be used until it has been repaired in a first-class manner. The working pressure suitable for the boiler should be decided upon from computation of the strength of all of its parts and should be limited to the maximum safe working pressure for any part of the whole construction, using factors of strength of materials and factors of safety appropriate to the condition, age and proposed use of the boiler. A hydrostatic pressure test should be applied that is 50 per cent. more than the proposed working pressure to determine whether the boiler is tight rather than to decide whether the proposed working pressure is a safe one, for that depends mainly on the accuracy of computations and good judgment that have been employed in fixing upon the safe working pressure.

Power Factor of Current Supply—In our plant power is purchased from a central-station company. We are penalized on a power factor of less than 80 per cent. What should be the power factor of the current furnished us? Suppose our average power factor for one month was 0.70 and the power factor of the current supplied us is 0.85, what would be our power factor if the incoming current had a power factor of 0.95? H. R. B.

The power factor of the supply circuit has nothing to do with the power factor of any load that may be connected to the source of supply. On the other hand, the power factor of the supply is the resultant power factor of all the loads supplied. If the power factor of the supply circuit was 0.85, as in the figure, and you were to connect a



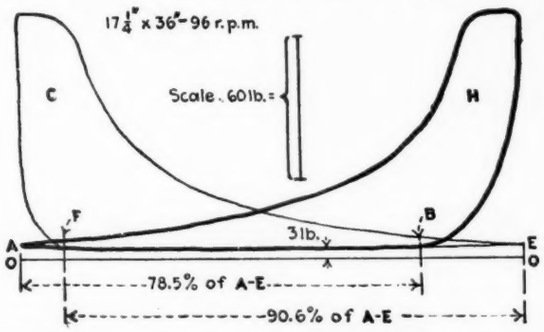
unity power factor load *B* to the system, the power factor of this part of the load would still be unity, but the power factor between where the load *B* is connected to the line and the generator will be improved; by how much will depend upon the relative sizes of the loads. Therefore the power factor of the power company's lines before your load is connected to it has nothing to do with what the power factor of your load will be, as that is determined by the kind of equipment you connect on the circuit.

Changing Voltage of D.-C. Circuit—What is the most practical way of changing 500-volt direct current into 100-volt direct current? C. A. C.

The only practical way to convert direct current of one voltage into direct current of another voltage is to use a motor-generator set. In the problem in question a 500-volt motor would be used to drive a 110-volt generator.

Heating Value of Exhaust Shown by Indicator Diagrams—The accompanying indicator diagrams are from a 17¼ x 36-in. engine running 96 r.p.m., the exhaust of which is used for heating paper driers. What is the value of the exhaust expressed in boiler horsepower? G. W. E.

It is fair to assume that the exhaust steam delivered by the engine has the same heat value as an equal volume of dry saturated steam at the same pressure. The volume of steam discharged during each exhaust stroke will be equal to the piston displacement from the beginning of the return stroke to the point of stroke where the exhaust valve is closed, or the point usually referred to as the beginning of compression. In diagram *H* the beginning of the return



stroke is represented at *A*, the point of closure of the exhaust is indicated at *B*, and as the distance *AB* is, by measurement, 78.5 per cent. of the length of the diagram, the volume of exhaust discharged from the *H* or head end of the cylinder is that same percentage of piston displacement for a complete return stroke represented by *AE*, the length of diagram. Similarly, for the *C* diagram, the distance *EF* represents 90.6 per cent. of the piston displacement of a return stroke in the crank end of the cylinder.

Neglecting the reduction of piston displacement in the crank end of the cylinder due to presence of the piston rod the displacement for a complete stroke of the piston would be $(17\frac{1}{4} \times 17\frac{1}{4} \times 0.7854 \times 36) \div 1728 = 4.87$ cu.ft. and in 96 r.p.m. for the fractions of strokes during which the piston pushes the exhaust from the cylinder, there will be delivery of $4.87 \times (0.785 + 0.906) \times 96 = 790.6$ cu. ft. of exhaust steam per minute at the pressure of about 3 lb. gage as indicated above atmospheric pressure line *OO*.

The density of steam at 3 lb. gage is 0.04512 lb. per cu. ft., so that the delivery would amount to $790.6 \times 0.04512 \times 60 = 2140.3$ lb. of steam per hour. The latent heat of steam at 3 lb. gage is 963.7 B.t.u. per pound and without crediting any recovery of heat from the condensate the exhaust would have a heating value of $2140.3 \times 963.7 = 2{,}062{,}607$ B.t.u. per hour. As one boiler horsepower is equivalent to 33,479 B.t.u. per hour, the exhaust would have a value of $2{,}062{,}607 \div 33{,}479 = 61.6$ boiler horsepower.

American Society of Heating and Ventilating Engineers

THE semi-annual meeting of the American Society of Heating and Ventilating Engineers held at Pittsburgh, Penn., Tuesday, Wednesday and Thursday, June 10, 11 and 12, with headquarters at the William Penn Hotel, was attended by over 150 members and guests. The meeting proved to be one of unusual interest on account of the opportunities afforded members and guests to inspect the laboratories of the Bureau of Mines, at which will be located the Research Bureau of the society. A special session was held in the auditorium of the Bureau of Mines Building, after which the admirable facilities afforded for research work in coöperation with the Bureau were witnessed with much gratification. Another notable feature of the convention was a joint session with the National District Heating Association, whose tenth annual convention was held at the William Penn Hotel during the same time. The joint professional session was devoted to the question of computing direct radiation for buildings and other subjects of leading interest to both associations.

Motoring, shopping and sight-seeing excursions were provided for the lady guests during business sessions of the association, and on Tuesday evening members and guests were entertained at the Carnegie Institute of Technology by a production of Shakespeare's "Twelfth Night" that was creditably presented by the School of Drama of the Institute. On Wednesday evening members and guests of both associations joined in an informal reception and dinner dance at the "Pines," and on Thursday afternoon they were entertained by a boat trip up the Monongahela River and visit of inspection to the McKeesport plant of the National Tube Co.

Business and Professional Sessions

The first session was taken up by the annual reports of the various chapters of the association and reports of committees on coöperation with United States Navy Department, and on Schoolhouse Standards; a paper on "Classroom Ventilation," by Konrad Meier, and "Heating and Ventilating the Standard Schoolhouse," by J. D. Cassell.

The Committee on Research announced that Prof. John R. Allen, who has been secured as director of the society's Bureau of Research, will assume active charge of the bureau on Aug. 1. Following the professional session held at the auditorium of the laboratories of the United States Bureau of Mines, the committee conducted members and guests on a tour of inspection of the splendidly equipped plant of the Bureau of Mines, which will be the headquarters of the Research Bureau.

The Bureau of Mines Plant

The main portion of the building is arranged for offices, auditoriums, meeting rooms, etc. One wing has been arranged for chemical research, where every facility and service required is supplied. The opposite wing is arranged for physical research. The first floor of this building is one long room, arranged with all service that could be expected to be used in physical research. A power house with ample capacity is in the rear of the building. The Fuel Research Laboratory is located in the power house and is provided with separate stack and arranged so that practically any fuel testing in actual practice under boilers or furnaces can be conducted.

The service consists of steam at high or low pressure; electric current, both direct and alternating; gas; hot and cold water; sewer connections, and compressed air. This service is available in practically any part of the plant.

Offices for the Bureau of Heating and Ventilating Research will be provided in the main building and are quite commodious and in every way suited for the work. The location of this building is of particular importance. Adjoining the Carnegie Institute of Technology, and within a block is the wonderful Carnegie Library. The University of Pittsburgh stands on the next hill, within plain sight and short walking distance. The Mellon Institute of Research is only a few blocks away. From this it may be seen that the atmosphere of scientific investigation and research and the assistance and coöperation that will be at hand is of the greatest value to this undertaking.

Co-operation with United States Bureau of Mines

The contract between the American Society of Heating and Ventilating Engineers and the Bureau of Mines is now being drawn to cover the activities of each in this coöperative work.

By this contract the society agrees to expend not less than $15,000 per year in this coöperative plan (it expects to spend at least $25,000). The society will furnish a director of research at a salary of $6000 a year; such assistants, investigators, engineers, stenographers, etc., as may be required and the funds available will permit; and the necessary instruments, appliances and apparatus for carrying on the work under investigation.

The Bureau of Mines is to furnish three investigators—one at a salary of $3000, one at $1800 and one at $1200. The Bureau of Mines will also furnish office space and janitor service, use of their physical and chemical research laboratories as space conditions may permit and the requirements may dictate; use of special laboratory in connection with the power house; service in the form of steam at high or low pressure; direct or alternating current; hot or cold water and gas, etc.; use of such instruments as they may have available.

It is needless to point out the value to the society accruing from this coöperation on the part of the Bureau of Mines. The bureau is anxious to coöperate in every way and the committee hopes and believes that such assistance may be mutually advantageous.

A report of progress in warm-air furnace research conducted by the engineering experiment station, University of Illinois, in coöperation with the National Warm-Air Heating and Ventilating Association contained in Bulletin No. 112 of the Experiment Station was presented by A. C. Willard, professor of heating and ventilation.

This is a preliminary report of progress under the present coöperative agreement between the National Warm-Air Heating and Ventilating Association and the University of Illinois for an investigation of warm-air furnaces and furnace heating systems.

The university through its engineering experiment station is to assume the responsibility of maintaining the necessary staff and conducting the investigation and, of course, it is further responsible for the reliability and unbiased character of all results obtained. Publication will be made from time to time in official bulletins of the station for the purpose of furnishing whatever scientific and technical data are developed in this work for the benefit of the engineering profession and the warm-air furnace industry.

The fundamental ideas involved in the methods used in this investigation, as well as the furnace plant itself and its essential features, were developed and put into operation by the Department of Mechanical Engineering of the University of Illinois in the spring of 1918.

Briefly stated, the principal objects of the investigation are:

1. To determine the efficiency and capacity of commercial warm-air furnaces under conditions similar to those existing in actual installations with leaders, stacks and registers to form a complete system.

2. To determine satisfactory and simple methods for rating furnaces so that the proper size and type of furnace can be definitely selected for the service required.

3. To determine methods of increasing the efficiency and capacity of furnace heating equipment and the advantages or desirability of certain types of design.

4. To determine the heat losses in furnace heating systems and the value of insulating materials as affecting the economy of the furnace or the leaders and stacks, and finally of the system as a whole.

5. To determine the proper sizes and proportions of leaders, stacks and registers supplying air to first, second and third floors.

6. To determine the friction losses in the cold air or recirculating ducts and registers and their proper size, proportions and arrangement or location.

7. Eventually, to make a study and comparison of outside and inside air circulation as affecting the economy and operation of furnace systems.

The report very completely illustrates and describes the instruments, apparatus and methods employed in the investigations.

A satisfactory method for measuring temperatures at many points had to be developed, and is accurate within one or two degrees.

The report recommends that for the maximum load conditions in practice the register temperatures should be taken as high as 175 to 185 deg. F., but for average conditions the register temperature should not exceed 150 deg. F.

In no case must the rate of combustion at any time require a draft in excess of 0.2 in. water gage.

The heat- and air-carrying capacities, and the heat losses of various kinds and sizes of leaders and stacks and other problems involving the length and pitch of leaders as well as the heights of and offsets in stacks are being solved by the tests now in progress.

A report of "Continuation of Work in Dust Determinations" was presented by Dr. E. Vernon Hill and Otto W. Armspach, and Monday morning's professional session was devoted to reading and discussion papers on "Utilization of Sprinkler System Piping for Heating," by A. W. Moulder; "Remodeling a Heating System," by Miss Helen R. Innis; and "Heating and Ventilating Systems at the United States Government's Smokeless Powder Plant, at Nitro, W. Va.," by G. W. Hubbard.

Joint Meeting with National District Heating Association

At a joint meeting with the National District Heating Association, the two associations discussed the report of the Rules and Regulations Committee of the National District Heating Association on Standard Rules for Computing Required Radiation, referred to in our account of the proceedings of the District Heating Association. The heating and ventilating engineers presented a paper on "Industrial Uses of Superheated Steam," by Alexander Bradley, and a paper on "Capacities of Reducing Valves for Steam Heating Systems," by James A. Donnelly as follows:

The capacities of reducing valves may be considered from two viewpoints. One, that they should not be greater than that of the inlet and outlet pipes to supply the steam and carry it away, with a reasonable or standard drop in pressure per unit of length, and that the area of the seats should be suitable for this rated capacity. The other viewpoint might be that the area of the seats should always be as large as the area of the inlet pipe and that the sizes of the supply and delivery pipes should be increased to correspond to the maximum capacity of the valve seats.

The latter method would often result in the use of a reducing valve and connecting nipples much smaller than the supply and delivery mains, and therefore much weaker structurally, from a mechanical standpoint. This would result in a design that is liable to rupture from expansion strains of the piping, and it may, therefore, be considered better engineering practice to rate the valves at the capacity of the inlet and outlet pipes and consider the necessary size of the seats for these ratings.

It is also desirable that the reducing valves and the sizes of the seats be so proportioned that the valves will have as large a lift as practicable in order that wiredrawing or cutting of the disks and seats may be avoided. This also results in a more accurate regulation, as smaller seats are easier to control.

Reducing valves for steam heating systems are usually made with the pipe size of the outlet double that of the inlet. They are usually provided with double seats of such a diameter that the combined area of the two is approximately equal to the area of the inlet pipe, although some have but a single seat, usually the diameter of the inlet pipe. The maximum movement of the disks is usually designed for one-quarter the diameter of the seats, thus giving full area of opening of the valve, but it is doubtful if a movement as great as this is obtained without considerable sacrifice of sensitiveness, and it will, therefore, probably be preferable to calculate their capacity on a maximum movement of one-eighth the disk diameter. This will also allow a reasonable factor of safety or possibility of overload sufficient for starting up a cold plant.

The velocity of flow of steam of a greater pressure into an atmosphere of a less pressure, increases as the difference of pressure is increased, until the delivery pressure becomes 58 per cent. of the initial pressure. The flow does not, thereafter, increase by a further decrease of the delivery pressure, and increases very slowly by a greater initial pressure, because the density and the weight to be removed increase with the pressure.

If the inlet pressure is but 25 lb. absolute, or 10 lb. gage pressure, and the outlet pressure atmospheric, the condition of 58 per cent. delivery pressure is present and the velocity of flow through a converging nozzle is 863 ft. per sec., resulting in a delivery of approximately 23 lb. per minute per sq.in. area of orifice. Tests by the author on fractional valves indicated that they had an efficiency of orifice of about 60 per cent. Applying this factor would indicate a delivery of about 14 lb. per sq.in. area of orifice per minute, or sufficient steam for the normal supply of 2800 sq.ft. of radiation with a reasonable allowance for the condensing effect of the piping system.

In the following table, the usual sizes of reducing valves are rated in accordance with the standard rating of steam mains, corresponding to the low-pressure side of the valve. These ratings divided by 2800 give the necessary areas through the valve seats for steam at 10 lb. gage pressure to be reduced to atmosphere.

RATINGS FOR THE USUAL SIZE OF REDUCING VALVES

Valve Size, In.	Rating	Seat Areas, Sq.In.	Diameter Double Seat, In.	Usual Diameter Double Seat, In.	Diameter Single Seat, In.
1 x 2	300	0.1	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{3}{4}$
1½ x 2½	500	0.18	$\frac{1}{2}$	1	$1\frac{1}{4}$
1½ x 3	900	0.32	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{3}{4}$
2 x 4	2,900	0.71	1	$1\frac{1}{2}$	$1\frac{3}{4}$
2½ x 5	3,600	1.29	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$
3 x 6	6,000	2.14	$1\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$
4 x 8	13,000	4.64	$2\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{4}$
5 x 10	23,000	8.21	$3\frac{1}{4}$	$3\frac{1}{2}$	$4\frac{1}{4}$
6 x 12	37,000	13.2	$4\frac{1}{4}$	$4\frac{1}{2}$	$5\frac{1}{2}$
8 x 16	78,000	27.9	6	$5\frac{1}{2}$	$8\frac{1}{2}$

The fourth column gives the required diameter for double seat valves, while the fifth column gives the diameter commonly used. The sixth column gives the required diameter for single seat valves.

It will be seen from this table that the areas of seats as commonly made are amply large even at the unusually low initial pressure of 10 lb. The necessary areas of seats as given above may be divided by 2 if the inlet pressure is increased to 35 lb. gage; by 3, if increased to 60 lb.; by 4, if increased to 85 lb.

The friction drop for the high pressure supply main will vary with the pressure used, but it may be said to average approximately 1 lb. per 100 ft. run, with the pressures in ordinary use.

At the closing professional session held on Thursday morning there was discussion and commendation of the good work reported in "Warm-Air Furnace Research" by Prof. A. C. Willard, and papers were presented on "Conservation of Coal by Saving Exhaust Steam," by William B. Hoyt; "Combustion," by Morgan B. Smith; and "Cracking Cast-Iron Sectional Hot Water Boilers," by C. R. Honiball, in which the author of the paper recited causes of deterioration and conditions that had come under his personal observation. In some cases it was noted that "thinning" of metal occurs at the bottom of sections in the firebox, leaving it no more than ⅛ in. thick.

National District Heating Association

NATIONAL District Heating Association held its tenth annual convention in the William Penn Hotel, Pittsburgh, June 10 to 13. About 150 members and guests participated in one of the best convention programs that have been carried out by the association. As stated elsewhere in this issue, the American Society of Heating and Ventilating Engineers simultaneously and at the same hotel held their summer meeting and several of the professional and social sessions of the organizations were joint sessions that brought about closer coöperation of the two societies. In addition to the joint banquet and boat trip up Monongahela River and visit of inspection to the McKeesport Works of the National Tube Co., an enjoyable trip was made by members and guests to the East Pittsburgh works of the Westinghouse Electric and Manufacturing Co.

J. C. Hobbs, Pittsburgh, Penn., was elected president for the ensuing year and D. L. Gaskell, Greenville, Ohio, was reëlected secretary-treasurer.

Report of Advancement Committee

There are on record a number of decisions in rate cases before state commissions where these bodies have established rates that show a good return on the investment. These decisions of commissions bring to our attention the necessity of doing all we can to help ourselves before asking for outside assistance in the form of increased rates.

Your committee has found plants earning a net return on what could be called a fair value, but the value allowed was complained of by the plant owners as being too low. It is a difficult thing to satisfy both sides of a rate case, and yet it is true that less real antagonism has been shown against heating-rate increases than any other utility business.

Most heating companies have been granted increases that have made it possible to weather the terrific conditions of the last few years. The high-cost period has brought out new problems or magnified what were considered minor problems. It has been the means of establishing a higher level of rates and has established the value of efficient operation. There will be a tendency to revert to lower rates, and probably the greatest problem before the companies is to keep the rates up to a point where a sufficient return is earned.

There has been a tendency to abandon some of the heating plants in the last two years. It is difficult to tell what the outcome will be. Many successful electric-plant operators will have nothing to do with a heating plant. Other equally good operators are earning a fair return on their heating systems. All the plants that have been abandoned were not economically sound. That is the real cause of stopping operation.

The change in electric production has made it difficult for the combination heating and lighting plant to exist. Large central stations with long transmission distances have put the smaller plant out of business. It is hard to find a steam plant exhausting into the atmosphere today. This will change conditions for the heating plant. It will require a straight heating plant with rates higher and investment lower. The high-pressure plant may fill this situation. It is a thing that must be studied.

The last two years of high fuel and labor costs have certainly jolted us into a desire to look about for all the possibilities of improvement we can find. In general it can be noted that the central heating industry needs higher rates and all the benefit it can get from the operation in combination with electric generating plants, or a design of a straight heating plant that will fulfill the conditions.

Report of the Station Operating Committee

On account of war conditions, it was out of the question to carry out any experimental work or tests. However, the committee endeavored to accumulate such data as might be procurable, and as would give the experience in successfully operated stations, and to report same. With this in mind, a list of topics was made up, and sent out with the request that such information as might be available on same be given. As a result the committee received valuable contributions from members on Proper Preparation of Fuel Before Its Delivery to the Fireman; Coal and Ash-handling Methods, Giving Advantages and Disadvantages of Different Systems; Station Organization with Reference to Obtaining Best Efficiency in the Burning of Fuel; The Bonus System; Causes and Remedies for Pitting and Corrosion in Boilers and Economizers: Experiences with Higher Steam Pressures.

Report of Public Policy Committee

The report of the Public Policy Committee covers subjects that have been most prominently brought out by conditions under which heating plants have been operated. It covers the following topics: (1) Rates and Their Relation to the Public; (2) The Relation of the Public and the Utility; (3) The Responsibilities of Labor; (4) The Trend Toward Socialism in Public Utility Operation.

The public is much more concerned in its service than in the rates paid for that service. When rates are mentioned, the public and the utility are too much like game chickens, always ready to fight, the one for a reduction in the price paid for the service, and the other for an increase in the return on its investment, which is usually inadequate. If this antagonistic attitude would bring relief to either of the parties, the fight might be worth while, but it does not. The public is not benefited by the saving in rate, and the utility cannot get any rate within the range or reason that would redeem it from the crushing burdens with which the public has from time to time loaded the utility. This, it is thought, is one of the most important phases of the subject that today faces the public and the utility.

The establishment of competent and quick acting tribunals, wholly divorced from local or political influence, is vitally essential to the life and usefulness to the public of the utility. Rates cannot be reduced from war-time fixing until war conditions are completely removed, and such condition is not in sight at this time. Public sentiment in the most favorable degree toward a utility should be encouraged, and needed changes in our laws regulating utilities should be such as to relieve them from many of the unjust burdens they now bear.

Major Charles N. Green, U. S. Engineers, reviewed the activities of the Construction Division of the Engineer Corps in the rapid preparation of camps and cantonments, the bulk of this work being accomplished under the direction of engineers recruited from civilian ranks.

Report of Accounting Committee

In the last report of the Advancement Committee it was recommended that a proper classification of accounts and a method for division of expenses of combined heating and electric utilities be worked out possibly in coöperation with the National Electric Light Association.

The Accounting Committee recommends that the Heating Association join with the committees from other public-utility associations, in working toward a uniform classification of accounts.

Standard Rules for Computing Required Radiation

It has been the desire of a great many members of the association for the last few years to have the National District Heating Association adopt a standard rule for figuring required steam and hot-water radiation. There have been several papers on this subject presented before the association, and as there was such a great number of rules used by the various member companies, some of which did not check within 50 to 75 per cent. of each other, the adoption of a standard rule has been carried over from year to year by the association with no action taken.

Two years ago when the Educational Committee decided to get up an association handbook, it was suggested that they adopt a standard rule for figuring radiation which would be known as the National District Heating Association rule and make it a part of the handbook.

The Education Committee was so busy that year with other matters that very little work was done on the radiation formula, and when the new committee on rules and regulations was appointed last year, the formulating of a standard rule for figuring radiation was turned over to them.

Numerous drafts of a proposed rule have been submitted to the committee in the last three months, and as there are fourteen members of the committee there has been a grat deal of criticism and discussion, which resulted in a great many changes and additions to the original draft. Some of the members were of the opinion that the scientific method was too complicated and that we should adopt a rule similar to rules known as Nos. 2 and 3. Other members were of the opinion that further additions should be made to the rule. As a result the rules which the committee submitted to the association for their approval and adoption do not meet with the individual ideas of each member, but the committee is agreed as a whole that if the proposed rules are adopted by the association as their standard, there is sufficient data, so that the various members of the association can compile simplified formulas to fit their local conditions.

The weight of discussion of the committee's report was to the effect that the proposed rules and methods of computing radiation were good when applied with engineering skill and due regard to conditions, and a motion was carried, recommending use of the rules for guidance, but not as the officially adopted standard of the association.

The Educational Committee's report made recommendations relative to compiling a loose-leaf handbook for use of men in the ranks as well as engineers and managers of heating untilites. The committee also made valuable recommendations on "Method of Turning in Steam in Large Lines," and a convenient method for determining the quality of steam furnished to the consumer.

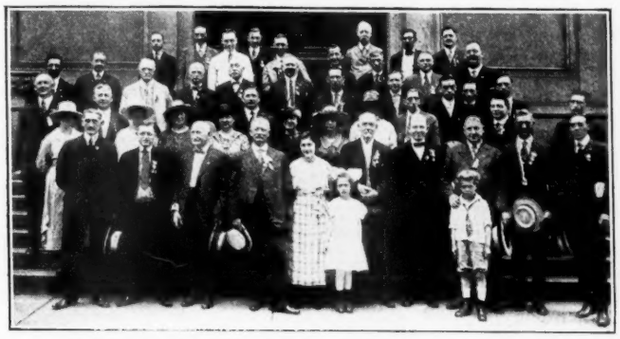
N. A. S. E. Convention at Troy, N. Y.

The twenty-fourth annual convention of the New York State Association of the N. A. S. E. was held in Troy, N. Y., Friday and Saturday, June 13 and 14, with headquarters at the Hotel Rensselaer. The main floor of the hotel was tastefully arranged for the use of the supplymen, there being more than sixty firms represented.

The sessions of the delegates were held in the small banquet hall in the rear of the exhibit. While the attendance was not up to the standard, the meetings were interesting and the members enthusiastic and full of "pep." The visiting committee of the past year, formed by the retiring president, Patrick Cassidy, received a vote of thanks for its good work and will be continued during the coming year. There are five local associations that are not connected with the state organization, and a strong effort will be made to get these locals to join the main body. There is no reason why the New York State Association should not be the largest in point of membership, and there will be a big campaign for members during the coming year.

The opening exercises took place at the Hotel Rensselaer on Thursday evening. John J. Hanlon, chairman of the local committee, occupied the chair, and introduced the various speakers. Mayor Cornelius Burns welcomed the convention to Troy and said it was the boast of the citizens of the city that they were never outdone in hospitality. Patrick Cassidy, state president, responded. Francis M. Hugo, secretary of state, complimented the delegates upon the excellence of the preamble of the association. He said that there should always exist an identity of interests, a perfect harmony and a close coöperation between the boss and the fellow who handles the throttle. He told the delegates how proud they should be of their profession, as the victorious outcome of the war was largely due to the supremacy of the American engineer and machinist. Edward J. Lee, of Albany, an old and honored member of the N. A. S. E., fittingly responded for the engineers. Mr. Lee's remarks were received with enthusiasm. At this juncture the ceremonies closed and the company adjourned to the exhibit hall where State President Cassidy officially opened the exhibit.

There were several features of entertainment, including auto rides, shopping tours and a theater party. The principal entertainment was the banquet on Friday evening. The dinner was appetizing and well served. The music was good, and the entertainment furnished by Bob Jones, of the France Packing Co., Billy Murray, of Jenkins Bros., and Jack Armour, of *Power*, was well received. The guests of honor included Past President William J. Reynolds; National Vice President John J. Calahan; Edward J. Lee, and Robert J. Tobin, the last acting as toastmaster.



SOME OF THOSE WHO ATTENDED THE TROY CONVENTION

William J. Reynolds was the installing officer of the newly elected state officers, as follows: Patrick Cassidy past president, New York City; Robert Tobin, president, Troy; Arthur E. Dowd, vice president, Rochester; William Roberts, secretary, Yonkers; William Downes, treasurer, New York City; Edward Hoag, conductor, New York City; Charles Eider, doorkeeper, Niagara Falls; Edward J. Lee, chaplain, Albany; S. T. Thackerberry, state deputy, Brooklyn.

It was decided that the next convention would be held in Niagara Falls, the second week in June, 1920. Before the adjournment of the delegates the memorial services for the 47 members who passed away during the year were conducted by Captain J. Barrett Mugford, of the Salvation Army.

The Holyoke Power Situation

An interesting situation has developed recently at Holyoke, Mass., where the increasing load upon the municipal lighting plant and the limited opportunity for expansion have combined to raise the question of the future line of development of the city's power supply. The Turners Falls Power and Electric Co., operating one of the largest steam and hydro-electric transmission systems in New England, has offered to sell energy to the city in bulk for distribution by the municipal lighting department, and an extended report on the operating cost of the station, past and estimated, has been prepared for the department.

Considerable local opposition to the purchase of energy was voiced at a public hearing on the power situation held in Holyoke June 11, on the ground that a local plant could be built by the city to supply energy as cheaply and probably with greater reliability than an outside system. Advocates of buying the power, however, emphasized the superior economy of the large water power and steam equipment of the Turners Falls company, and pointed out that without the cheapest power available a modern industrial city cannot develop in competition with other communities. A wise conclusion was reached in a unanimous vote recommending the employment of an independent engineer to investigate and report upon the entire situation with advice to the city as to the best course to pursue, taking all possible factors into account. In the last analysis what modern industry wants is reliable power at the lowest feasible cost, and sentimental considerations have no place in deciding such a question as this, which affects the individual taxpayer as well as the commercial welfare of organized industry. Political considerations have no place in settling a large and important engineering matter such as that now before the citizens of Holyoke.

Engineering Council Notes

Contributed by M. O. LEIGHTON, Chairman
National Service Committee

The Committee on Classification and Compensation of Engineers of the Engineering Council have submitted a report of their activities in the Federal, the Railroad and the Municipal and State sections. This work has been mainly the preparation of classification schedules, the study of conditions affecting salary scales and the analysis of data collected. To facilitate this work in the Federal section a letter was sent to each departmental secretary outlining the work of the committee and requesting a list of engineering bureaus in his department and in issuing instructions to chiefs to furnish the needed data. Favorable responses were received from all departments excepting the War Department, which declined to furnish the information desired. A questionnaire was also prepared to be sent to the chief engineers of the railroads under Federal control on the supposition that the salaries of all the men in the various departments of the Railroad Administration were a matter of public knowledge.

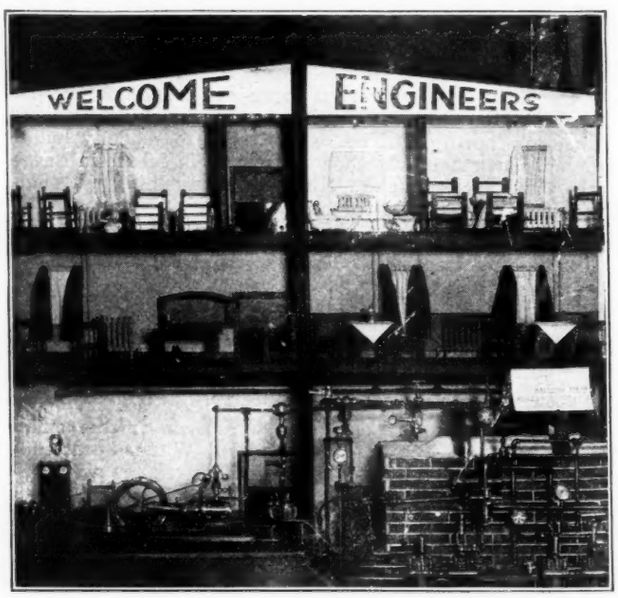
Before sending out this questionnaire Director General Hines was consulted and said that he did not think the matter should be approached in this manner. However, he stated that he could see no objections to our getting the information from members of the Founder Societies. The railroad section is confining its initial efforts to securing the required data from members of the Founder Societies. In the municipal and state sections the committee has found it necessary to undertake the formulation of a standard classification of positions and duties. The fitness of this schedule is now under consideration by the committee. As soon as an agreement shall have been reached, it is proposed to incorporate it into a questionnaire for circulation among the engineers of all states and the more important cities with a view to determining present compensation and changes which should be made.

In attempting to formulate standard rates of compensation for professional engineers, the first task is to find what rates are actually in force; the second task is to find what adjustment should be made to correspond to the great change in the cost of living. How great this change has been is realized by few. A record of average prices of the necessities of life, kept by R. G. Dun & Co., shows that prices have increased steadily for twenty-two years. On staple articles purchased July 1, 1897, for $72.45, the price had risen on Oct. 1, 1918, to $233.23. The unions have compelled an increase in wages for their members, and the unskilled laborer has been, especially during the war, practically able to set his own price on his services. No such increase has come the way of the salaried professional man. What increase has been granted is only too often wholly inadequate to make up for the increase in the cost of living. There is no doubt that if an unprejudiced investigation were made, it would show that the large proportion of salaried workers in professional occupations have been unable to pay their living expenses from their earnings for the last three years. Every indication is that the present condition of high prices will stay for several years yet. If this is the case, then the salaried worker is entitled to have his pay brought back in purchasing power to where it was fifteen years ago.

There is another aspect to the compensation of the professional worker which has frequently been misunderstood. The pay of professional engineers has for many years been based largely upon the idea that a young man in the earlier years of his work should expect a modest salary because of the future he might look forward to. Perhaps this idea was right when the demand for engineers was greater by far than the supply and the few properly trained men that were turned out by the engineering schools and engineering workshops rapidly worked themselves to positions of large responsibility, commanding high salaries. This is far from the conditions confronting the engineering graduate today. A very few can ever rise to high positions. The man who does is always a man of exceptional ability, and the man of exceptional ability alone is able to discount his early salary for the sake of his prospect. To hold out similar prospects for the average technical worker, which they have not one chance in twenty of ever attaining, is gross deception. The committee believes therefore that the dollar of salary must be considered with regard to what it will purchase today and is likely to purchase next year, and not with regard to the value of the dollar ten or fifteen years ago. This increase is not only necessary as a matter of justice to the engineer, but in order that engineering work may be maintained on the plane that it must be to secure economical and efficient work. There is no economy in paying such men at rates inadequate for their support. It merely tends to drive the abler men into other occupations and to leave in charge of the work only those of less ability, who are unable to make a change.

Iowa State Convention, N. A. S. E.

On June 11-13 the Iowa State Association of the National Association of Stationary Engineers held its sixteenth annual meeting at Marshalltown, Iowa. The "Victory" convention was one of the best in the history of the state association. The attendance was good, exhibitors had



MODEL OF HOTEL POWER PLANT

to be turned away for lack of space, there was a good selection of interesting papers, and the business sessions were of the short, snappy variety for which the Iowa Association is noted.

On Wednesday afternoon the first executive session was called to order by Royal H. Holbrook, owing to the temporary absence of President Mullin. Mayor Wilson extended a hearty welcome to the engineers. In the response Fred Raven, national secretary, stated that efficiency was the motto of the association and pointed out that there is urgent need of better-educated engineers to lower the cost of production under the handicap of higher prices for everything entering into the generation of power. Herman Hiese, vice president, officially opened the convention, appointed a credential committee and conducted a motion for adjournment to visit the Iowa Soldiers' Home. "From Ore to Finished National Pipe" was the title of the first paper, and the second was, "The Flow Meter and Its Application in the Measurement of Steam, Water and Air," by J. B. Hoelz, of the General Electric Co. Outside of the records made available by the meter the big thing in its use, according to Mr. Hoelz, is the education of the fireman. By watching it he can see the immediate effects of everything

he does. The meter assists in equalizing the load on the various boilers of a plant, guides the fireman in setting the draft or regulating the feed water, indicates a loss of effective grate area, leaky tubes, surface covered with scale or soot, or in fact anything that tends to reduce the output. The use of a steam meter on the supply to a turbine was also important as it would immediately show a rise in water rate, which for the same load would indicate there was something about the turbine requiring attention.

C. M. Brigham, of the C. A. Dunham Co., in an illustrated address pictured the evolution of heating, the troubles formerly prevalent with single-pipe and two-pipe systems and the present way of removing air and water of condensation by means of a Dunham radiator trap.

On Thursday morning there was a short business session, followed by a practical talk on pressure gages by G. F. Ruopp, of the Marshalltown Manufacturing Co. The speaker explained the action of the bourdon gage and showed different types of tube for light and heavy steam pressures and tubes for ammonia and hydraulic gages. During the afternoon a tour of inspection was made to the principal manufactories of the city, including the Fisher Governor Co., C. A. Dunham Co., Central Foundry Co., Daily Boys and Their "Pop," and Marshalltown Manufacturing Company.

Friday morning the principal order of business was the appointment of a committee of five, including the president and secretary, to act in conjunction with the Central States Exhibitors' Association and take full charge of the state convention financially, educationally and socially. It has been a number of years since the Iowa association has been in the exhibitors' circuit, and it is gratifying to see them back in the good old way.

Election of officers resulted as follows: President, Herman Hiese, of Des Moines; vice president, H. G. Hammond, of Davenport; secretary, P. P. Kramer, of Des Moines; treasurer, J. A. Coulson, of Sioux City; conductor, S. C. Dike, of Dubuque; doorkeeper, John Rockwood, of Clinton; state deputy, Royal H. Holbrook, of Cedar Rapids. Dubuque was the choice for the next convention city.

The morning sessions ended with an interesting lecture on the "Cost of Making a Kilowatt-Hour," by Arthur G. Huntington. The high light of the talk was that the engineer must make himself part and parcel of the balance sheet of the firm. The engineer is responsible for 10 to 20 per cent. of the cost of doing business, and he must impress upon the management the part he plays in connection with the balance sheet.

On Friday afternoon George F. Hessenbruch, of St. Louis, favored the convention with a lecture on isolated plants. He pointed out that the central station had many advantages over the isolated plant in producing current cheaply. They had many technical men who were experts in their particular line, had every kind of instrument to give all operating data necessary, a complete trained crew for the work and the privilege of consulting with the specialists previously mentioned. The isolated plant did not have the coöperation and coördination of the central station, and in addition it was usually handicapped by the management insisting on keeping down expenses, although this situation had been relieved somewhat by the education received in the past two years. As to relative costs the isolated plant no longer had the marked advantage of prewar days. Whether the advantage rested with one or the other depended a great deal on balancing the steam and electrical services and the particular conditions existing in each case. No general deductions could be made that would cover all cases. The speaker reviewed his experience in 39 isolated plants that had been taken over by the central station to supply all services. Eleven of these stations have now resumed operations with their own plant owing to the high cost of the service, and it is probable that the balance of the 39 plants will follow suit before the end of the year.

Engineered by the Fisher Governor Co. and the C. A. Dunham Co., the banquet Friday evening was a great success. L. C. Abbott acted as toastmaster. Prof. W. H. Meeker, of Iowa State College, made the first address, his topic being the "Evaporative Performance of Steam Boilers." He reviewed the growth in the size of boilers and incidentally showed that it had not kept pace with the increase in present ratings. There were several ways by which engineers were now endeavoring to increase the operative performance of boilers and to reduce the space occupied. One way was to rearrange the heating surface so as to utilize more of the radiant energy from the fire. Increasing the velocity of the flow of gases and the flow of the water within the tubes were also factors influencing the economy and increasing the capacity of the boiler. Another factor being given consideration is the use of cones on the heating surface to break down the film of dead gas next to the plate. There are possibilities of increasing the heat flow from 65 to 75 times, as compared with the results now obtained with plain surfaces. Fred Raven, national secretary of the association, followed, briefly expounding the reasons for the existence of the N. A. S. E.

As a fitting close to a banquet of engineers, Royal H. Holbrook told in a most interesting way the story of James Watt, reviewing his early days and following up his later career as an inventor. On this subject Mr. Holbrook is an authority. He has made a most careful study of all available literature dealing with the early days of the steam engine, and it was the unanimous opinion that his discourse from the standpoint of interest was exceptional.

Among the exhibits at the convention a model hotel power plant consisting of boilers, engines, generators, steam pumps, heating system, feed-water heater, steam trap, regulating valves, and all complete, made in miniature size and operating at a pressure of 30-lb. gage, attracted a great deal of attention from the visitors. The miniature plant performed the services of standard-sized apparatus, supplying light and heat, and being equipped with the necessary gages, safety valve, etc., used in the average plant. It had been prepared by the Fisher Governor Co. and the C. A. Dunham Co.

American Order of Steam Engineers

The American Order of Steam Engineers held its thirty-third annual convention at Atlantic City, N. J., during the week beginning June 9, with headquarters at the Continental Hotel. The attractive location of the meeting this year brought out a full attendance.

The several sessions of the delegates were held in the Morris Guards Armory, a block from the hotel headquarters. The main drillroom of this building was tastefully decorated and arranged for the use of the supplymen in the display of power-plant equipment and engine-room accessories. The exhibit was liberally patronized, fifty-three firms occupying booth spaces.

Many important subjects were discussed at the sessions and measures conducive to the welfare and uplift of the engineers in general were passed upon. The treasurer's report showed that the organization is on a sound financial basis. On Tuesday evening, in the exhibit hall, the engineers gave a complimentary entertainment, which was greatly enjoyed by a large attendance. The entertainment on Thursday, under the auspices of the supplymen, proved a success in every particular.

At the final session of the delegates the following supreme officers were elected and installed: W. Scot Price, chief engineer; Philip S. Kirkwood, first engineer; Harry Dunn, recording engineer; William S. Metzler, corresponding engineer; William R. Smith, treasurer engineer; Dan Bunting, master mechanic; Harry Oler, junior master mechanic; William Kurtz, inside sentinel; William Arnold, outside sentinel; D. B. Heilman, trustee; and James Lightfoot, chaplain.

The American Supplymen's Association elected its officers for the ensuing year, as follows: Porter G. Jones, Dearborn Chemical Co., president; William Lindenfelser, Jr., Texas Co., vice president; Roy C. Downs, Engineering Supply Co., secretary; John W. Armour, *Power*, treasurer. An executive committee consisting of twelve members representing leading supply houses was elected.

At the conclusion of the memorial services on Friday, it was decided to hold the next convention in Baltimore, in June, 1920.

Progress in Adoption of A. S. M. E. Boiler Code

The American Uniform Boiler-Law Society in Bulletin No. 13, dated June 10, makes a report of the activities of the society in the different states since Mar. 10, 1919, the date of the last bulletin. The report of progress by states follows:

Delaware—The Legislature convened in January. The enabling act was introduced in the Senate by I. L. Long, and known as Senate Bill No. 144. H. B. Bradford and Mr. Cox of the Edge Moor Iron Co, rendered valuable service. At the request of Senator Long, we addressed the Senate and House in the interests of the A. S. M. E. Code and the bill, which was unanimously passed by both houses and signed by Governor Townsend on Apr. 8.

The bill provides for a board of boiler rules consisting of five members: One a professor of mechanical engineering; another a manufacturer of boilers; another a user of boilers; another a mechanical engineer; and the fifth a licensed stationary engineer. The bill carries an appropriation of $300 for the printing and distribution of the rules formulated by the board.

Rhode Island—The Legislature convened on Jan. 2. Our bill, known as Senate Bill No. 159, was introduced by George T. Gorton. The bill was in charge of Judge James Harris, of Providence, and had the active support of the leading manufacturers, engineers and others. It was passed unanimously by both houses and signed by Gov. R. Livingston Beekman on Apr. 23.

The bill carries the following provisions: The appointment of a chief inspector, salary $1800 per year; the appointment of one or more deputy inspectors, salary $1200 per year each, and all traveling and other necessary expenses incurred by him in the discharge of his duties. The chief inspector must formulate and adopt a standard code of rules for the construction, equipment, installation and inspection of boilers, which standard and rules shall be based upon the standard code of rules published and enunciated by the A. S. M. E., and the inspector shall amend such standard code of rules from time to time, basing such amendments on any amendment made by the A. S. M. E. in the standard code of rules published and enunciated by the society.

Exemptions: Boilers subject to Federal inspection and control, together with boilers carrying a pressure of 15 lb. or less per square inch steam, or 30 lb. or less per square inch water; and boilers that are inspected and insured by companies chartered for the purpose of insuring steam boilers and authorized to do business within the state during the time that such insurance remains in force, provided due evidence of such inspection and insurance shall be furnished to such inspector, either by the company furnishing such insurance or by the person or persons insured. The act takes effect Sept. 1, 1919.

Missouri—The Legislature convened Jan. 8. The enabling act, known as Senate Bill No. 622, was introduced in the Senate by Conway Elder and in the House by Hugh K. Wagner. James A. McKeown, president of the John O'Brien Boiler Works Co., St. Louis, was in direct charge of the bill, assisted by Mr. Burton and Mr. Hester, of the Kewanee Boiler Co., together with C. D. Ashcroft and J. P. Morrison, of the Hartford Steam Boiler Inspection and Insurance Co.; D. W. Chipman, Jr., Maryland Casualty Co.; Edward W. Schadek, the St. Louis Boiler Manufacturers' Association, the Engineers' Club and the St. Louis Section of the A. S. M. E., as well as Senator Elder and Representative Wagner. The bill has passed both branches of the Legislature and is now in the hands of Governor Gardner for his signature.

The bill creates a board of boiler rules consisting of five members, four of whom shall be citizens of the state of recognized knowledge of the construction and use of steam boilers. The fifth member shall be the state factory inspector. The rules and regulations as formulated by the board of boiler rules shall conform as nearly as possible with the Code of the A. S. M. E. The rules shall become effective upon the approval of the governor, but rules applying to the construction of new boilers shall not become effective until Jan. 1, 1920. The sum of $1000 is appropriated for printing and distribution of the rules formulated by the board.

Michigan—The Legislature of 1917 passed a bill authorizing the appointment of a board of boiler rules to formulate rules and regulations for the construction of boilers. The rules and regulations so formulated were subject to the approval of the governor and attorney general. The following persons are members of the board: G. W. Bissell, chairman; E. C. Fisher, vice president; G. L. Christensen, secretary; R. I. Higgie; J. C. McCabe, chief inspector, Detroit. After a great deal of time and work on the part of the board and others, Michigan is now operating under the Code.

New York—Under Section 91 of the Labor Law, the New York State Industrial Commission in 1917 adopted the Code—to apply only to factory buildings. There was no provision made for the inspection of boilers in any class or type of buildings other than factories in which steam boilers were being operated above 15 lb. pressure per square inch. A bill was introduced by the Boiler Inspection Department, in both Senate and House, which authorizes the Inspection Department to make inspections of all boilers carrying a steam pressure above 15 lb. per sq.in. in all classes and types of buildings, and was known as House Bill No. 257. We gave this bill our unlimited support, appearing before the Senate and House Committee. The bill passed both houses, has been signed by Governor Smith, and is now known as Chapter 299, Laws of 1919. We understand the Industrial Commission will adopt the 1918 edition of the Code.

Washington, D. C.—The General Engineering Depot now specifies that all new boilers are to be built in accordance with the A. S. M. E.

Florida—The Legislature convened on Apr. 3 and our bill, known as Senate Bill No. 399, was introduced by Senator Carlton. We have the active support of the Florida Engineering Society, the attorney general and others. We were in direct touch with the situation, having visited Tallahassee with C. S. Hammatt, of the Florida Engineering Society, and appeared before the Senate committee, which reported the bill favorably. The bill has passed the Senate and is now in the House.

Alabama—The Legislature convened Jan. 10 for a fifty-day session. The Legislature convenes once in four years. Our bill has been introduced and is known as House Bill No. 330, and will be acted upon after July 8. W. P. Caine, chairman, Birmingham Section A. S. M. E., has been active in our behalf, assisted by manufacturers, the Alabama Branch No. 3 of the N. A. S. E. and others.

Georgia—The Legislature convenes on June 27, and our bill, which has been carefully drawn, meets with the approval of the governor, the commissioner of commerce and labor, the Georgia Manufacturers Association and the Atlanta Section of the A. S. M. E. We understand that the governor will recommend the legislation in his message to the Legislature, and we believe that Georgia will adopt the Code.

Increasing recognition of the value of the Code is indicated by its use in technical schools as a text or reference book. It is now used as a reference book at Stevens Institute of Technology, Sheffield Scientific School of Yale University and in the course in boiler design at the Rensselaer Polytechnic Institute. It is reported that the Code is also in use at the Virginia Polytechnic Institute, Georgia School of Technology, the University of Texas, the Tulane University of Louisiana and the University of Florida.

It is, moreover, used in the Republics of Argentine, Paraguay and New Zealand. Also the Government specifies boilers in use at the Canal Zone and according to Specification No. 2362 for power-plant equipment at the Naval Training Station, Newport, R. I., "boilers and accessories used by this department are to be constructed to the A. S. M. E. Boiler Code."

The following states and cities have adopted the A. S. M. E. Boiler Code: States—New York, New Jersey, Pennsylvania, Delaware, Michigan, California, Missouri, Rhode Island, Wisconsin, Minnesota, Ohio, Indiana. Allegheny County, Penn. Cities—Detroit, Mich.; Erie, Penn.; Kansas City, Mo.; St. Louis, Mo.; Philadelphia, Penn.; St. Joseph, Mo.; Chicago, Ill. (will accept).

Pulverized Fuel for the Railways

At the eleventh annual convention of the International Railway Fuel Association, held in Chicago the week of May 19, the committee on pulverized fuel, of which W. J. Bohan, of the Northern Pacific Railway, is chairman, presented an interesting report consisting of a summary of results obtained by the use of pulverized fuel in locomotives. To date five different American railroads—the Atchison, Topeka & Santa Fe; Chicago & North Western; Delaware & Hudson; Missouri, Kansas & Texas, and the New York Central—have successfully operated during test periods individual locomotives equipped for burning pulverized coal. These tests were all made under regular service conditions and demonstrated that locomotives burning pulverized coal will meet the train-handling conditions imposed by the different classes of service. None of the locomotives tested were in service at this time, it being necessary in most instances on account of war activity and the demand for power to remove the pulverized-fuel equipment and discontinue the experiments. Following are summaries of results obtained from three different sources:

A carefully conducted test between two engines of the same class, one burning pulverized coal and the other hand-fired, showed that a saving of 23 per cent. in fuel burned could be made by burning pulverized coal. The main difficulties encountered were the slagging over of the flue sheet and burning out of the brick arch. The slagging was largely overcome by an air jet to blow off the slag accumulations. A number of burner arrangements were tried, but it was found impossible to prevent the rapid burning out of the brick arch. The cost of replacing the arch brick largely overcame the saving in fuel, and the delay to the locomotive was a decided drawback. A comparison of total costs of hand-firing versus pulverized-coal firing on the locomotives tested, which include cost of pulverizing, cost of handling, cost of arch maintenance, interest and depreciation, showed the hand-firing to be most economical. In fairness to the pulverized coal it was thought possible to design a firebox that would avoid such troubles as burning out of the brick arch and show an advantage in favor of the pulverized coal.

Cost of Pulverizing

A second report stated that pulverized fuel had been burned satisfactorily. All the steam needed had been generated, with splendid control all the time, when using 60 per cent. anthracite and 40 per cent. bituminous coal, the latter fuel being necessary to increase the volatile. Economy was quite another thing, and unless a poor or byproduct coal could be purchased at a price that would absorb carrying charges, operation, etc., of a pulverizing plant and not exceed the price of a satisfactory lump coal, the question would bear careful analysis. There is no saving in the quantity of fuel used when pulverized; in fact the difference is in favor of the lump coal. Pulverizing costs between 45 and 50 cents per ton.

By a third source the burning of pulverized fuel in a locomotive was considered easy and had proved satisfactory. The only difficulties were with the drying, pulverizing and handling of the coal, and also the danger in connection with it. In case of a large number of engines being equipped to burn pulverized coal, were the plant to be blown up, burned or otherwise made inoperative, the locomotives would be tied up until the plant was in service again.

Something like 200 pulverized-fuel installations on stationary plants were in operation throughout the country. These plants were reported as successfully burning all grades and classifications of anthracite, bituminous, subbituminous and lignite coals in the pulverized form.

The development of the art of burning pulverized coal during the past two years has shown marked progress in that the experimental work done and tests made, although still incomplete, have demonstrated the apparent soundness of the principle of burning coal in a finely divided form in suspension, and that the complete commercial success depends upon the further careful working out of such details as correct determinations of proper fineness of the various grades of coals and economical and efficient methods and apparatus for preparing, storing and transporting the pulverized coal to the stationary plant or to the locomotive furnace.

It has not been clearly established that coal ground to the extreme fineness and dried to the extent recommended by most of the supporters of pulverized coal best meets the conditions of the practical user operating under widely diversified conditions. The tendency of explosion and spontaneous combustion, which is always present in coal of this character, should be eliminated entirely if possible to do so. The tendency of reabsorption of moisture in containers and transmission piping in stationary plants and at coaling stations of railroads will always be a problem in climates having extreme variations of temperature and humidity. Experiments should be made to determine if thoroughly air-dried coal ground to the fineness of, say, coarse granulated sugar and burned in suspension in specially designed furnaces will not produce greater overall economies.

Pulverizing Coal on Locomotive Tender

Further, in so far as the use of this kind of fuel on locomotives is concerned, it seems advisable to give more careful consideration to the individuality of the flexible steam locomotive as it exists today. It is not without the realm of possibility that a pulverizing and stoking device might be arranged that would prepare any grade of coal on the tender and deliver it to the firebox in the pulverized form, thus eliminating all expense incident to preparing and transporting pulverized coal from a central plant, which things create a great deal of doubt about the success of pulverized fuel at the present time. The same thing would also apply to a stationary plant in a modified form.

Much ill-advised engineering work and experimenting has been done and some snap conclusions have been rendered without careful analysis of the problem and without doing the very essential laboratory work necessary to establish fundamental facts. Some hurriedly prepared and conducted tests with incomplete and inadequate facilities and equipment have been made, particularly on locomotives on busy railroads during periods of heavy traffic movement. Such tests are more or less void of results, not only from lack of preparation and facilities, but also because employees cannot give them proper attention. For these reasons also adverse opinions and doubt about pulverized fuel prevail in the minds of many.

It did not seem to the committee that the laboratories of the great universities were being used to sufficient extent. Many of these universities have thoroughly equipped laboratories, and could thoroughly work out all the technical questions and lay the foundation for reasonably operative devices before making field applications.

"Heat Balances" and "Cash Balances"

It is particularly noticeable in the reports of pulverized-fuel tests received by the committee that practically all dealt with fuel economy only and with a deluge of figures and "heat balances" conclusively proved fuel economy to everybody's satisfaction. Not enough has been said about "cash balances." In this respect conclusive evidence is lacking about pulverized coal, at least in so far as the committee has been able to develop after careful inquiry.

There is little or no question about the ultimate practicability, efficiency and economy of burning coal in a finely divided form, both in stationary plants and locomotives. To develop this fact to a practical conclusion requires thorough coöperation of manufacturer and user. In view of the immense supply of bituminous, lignite and other grades of coals of various characteristics peculiarly adapted to the pulverized method of burning, it is suggested that as soon as business conditions again adjust themselves the railroads, with the assistance of manufacturers and universities, make the necessary conclusive and exhaustive tests and develop the fixed principles of methods and apparatus necessary to successfully meet the urgent demands for vastly more economical burning of coal. This is not a question of self-interest of either manufacturer or particular industry. It is one of national interest and urgency.

A National Employment System

A bill which aims to establish a national employment system has been introduced into the Senate by Senator Kenyon. This system would be called the United States Employment Service and be a bureau of the Department of Labor. It is designed to serve both sexes and plans to coördinate the public employment offices in the different states to create a uniform standard of supply and demand of labor by assisting when necessary in the transportation of workers to meet labor shortages in different sections of the country. It provides for an appropriation of four million dollars to be distributed on a per capita basis, among the different states for the maintenances of these offices.

The National Research Council

A bill recently introduced by Senator Gronna provides for "aid in the promotion of engineering research, industrial progress and scientific investigations." The bill also aims to assist in the development of national resources and the distribution of useful and practical information pertaining to these questions among the people of the country. It would appoint a national board of engineering and industrial experts, this board to be called the National Research Council. Its duties are to be the organization and coördination of engineering and industrial research in each of the states. Although the members of this board will receive no compensation for their services, the bill provides that actual personal expenses will be paid by the Government.

Russian Water-Power Possibilities at Dnieper River Rapids

V. V. Tchikoff, consulting civil engineer, Berkeley, Calif., writing in the *Engineering News-Record*, estimates the total potential water power of European Russia alone to be 20,000,000 hp. or more. This is mostly concentrated in the border regions of Russia. The Caucasus has about 10,000,000 hp., and there is about 2,000,000 hp. in the north lake region. All the hydro-electric stations of European Russia have only about 250,000 hp., and most of these stations are small.

The rapids of the Dnieper River present one of the most interesting possibilities for early utilization. The problem of developing these rapids has been worked out by many Russian and foreign engineers. This project was divided into two phases. The phase first was based upon the 37-year midsummer minimum discharge of 11,000 sec.-ft., corresponding to a turbine capacity of 238,600 hp. nominal, with a maximum of 316,800 hp. during the flood months of spring. The minimum discharge for a 15-day period is 15,100 second-feet.

For the second phase of the project there would be utilized about 22,000 sec.-ft., corresponding to a turbine capacity of 350,000 hp. nominal and 465,000 hp. maximum, and a total of 588,600 hp. nominal. For this there would be necessary auxiliary steam plants of half the turbine capacity, working 90 days per year. The maximum turbine capacity was assumed as 1.33 times the nominal capacity. The construction cost of the dams, locks, etc., was estimated at about $25,000,000, and of the turbines, generators, etc., $16,500,000 for the first and $21,000,000 for the second phase, including the auxiliary steam plant, but not the transmission lines to Ekaterinoslav and Alexandrovsk, which were counted at $4,400,000. The profits of a year's operation for the first phase are estimated at $1,480,000, and for the second phase $1,700,000.

Two Hundred Million Dollar French Contract to American Firm

The Vulcan Steel Products Co., 136 Liberty St., New York City, has just received a cost-plus contract, valued at $200,000,000, for rebuilding the Nancy district of France. The preliminary work of accumulating an organization and obtaining bids on machinery and equipment of all kinds will be started at once, so that the actual construction work may go forward the moment the peace treaty has been signed.

Associated with the Vulcan Steel Products Co. are MacArthur Brothers and the McClintic-Marshall Co., which will handle the construction work. French labor will be used, and it is understood that preference will be given to French manufacturers of machinery. However, a vast amount of American machinery of all descriptions will be purchased.

The German War Commissary states that Germany's coal production is decreasing in all districts, because the pay is no longer based on the work done but has a minimum of 16 to 18 marks ($3.81 to $4.28, at normal exchange) per day. The present coal production in the Ruhr district is 9000 to 10,000 tons per day, compared with 34,000 tons in peace times and 24,000 tons during the war. In upper Silesia the daily output has been reduced to 2000 carloads, compared with 14,000 in peace times and 11,000 during the war.

New Publications

INDUSTRIAL MAP OF NEW ENGLAND

The First National Bank of Boston, through its commercial service department, has published an interesting industrial map of New England, showing by symbols and cuts the leading industries located geographically in the respective cities and towns. A key to the symbols, included in the map, enables one to locate at a glance the various industries. There is also a carefully worked out table of the industrial towns arranged by states, and the leading industries in each city and town are shown, which should be of interest and value to merchants and manufacturers throughout the United States. To further the development of foreign trade and to enable the foreign buyer to become familiar with the products which New England manufactures, this map will be published in other languages for distribution in the foreign markets of the world.

Personals

M. L. Requa has resigned as general director of the oil division of the United States Fuel Administration to accept a position with one of the large oil concerns.

W. H. Goodrich has resigned as chief engineer of the Stamford (Conn.) Gas and Electric Co., to become New York district sales manager of the McClave-Brooks Co.

Ralph T. Stone, who has been sales engineer at the New York City office of the Sullivan Machinery Co. for several years, has been put in charge of the company's new branch office at Room 810, Park Building, Cleveland, Ohio.

Major George W. Semmes, vice president and chief engineer of Akerlund & Semmes, Inc., has returned from France after nearly two years of service at the front. He will confine his activities chiefly to the management of the gas-producer department.

George R. Richey has been appointed New England sales manager for the Sullivan Machinery Co., to succeed George E. Wolcott, deceased. Mr. Richey was long associated with the late Mr. Walcott as sales engineer for the company in New England and eastern Canada.

Prof. Charles J. Tilden, well-known civil engineer and for many years head of the department of civil engineering at Johns Hopkins University, has been placed in charge of the new department of engineering mechanics at Sheffield Scientific School of Yale University.

Foster Callahan, recently released from service in the United States army, is acting as representative in several Southeastern States for the Safety Insulated Wire and Cable Co. Mr. Callahan formerly covered this same territory in another connection and is well known and popular in the electrical industry.

Vernon T. Brauns, who has a large acquaintance with chief and valuation engineers of railroads of the United States, has just assumed the management of the American Blue Print Paper Co. Some time ago, Mr. Brauns won national recognition through promoting a process for reproducing tracings for presentation to the Interstate Commerce Commission.

Oscar F. Rabbe has taken over the management of the Toledo district of the L. S. Shaw & Co., sales engineers for boiler-plant equipment. He is well acquainted with Ohio engineers and is going back into the sales field after a number of years' connection with the operating departments of the Toledo Railway and Light Co. and the LaSalle & Koch Co. His office will be at 301-302 Spitzer Building.

Engineering Affairs

The New England Water Works Association and the Boston Society of Civil Engineers will hold a joint field day and excursion at Pemberton, Mass., June 25.

The American Boiler Manufacturers' Association will hold its thirty-first annual convention at the Lafayette Hotel, Buffalo, N. Y., June 23-24. An interesting program is being arranged.

Business Items

The Chalmers Pump and Manufacturing Co., of Lima, Ohio, which is a reorganization of the Chalmers Manufacturing Co., has purchased the entire pumping machinery business of the Canton-Hughes Pump Co., of Wooster, Ohio. The officers of the new company are: C. S. Brown, president; Frank D. Shumate, vice president and sales manager; Fred Biszantz, secretary and treasurer.

The Niagara Falls Power Co. has made the following changes in its personnel: Paul A. Schoellkopf, who was one of the first vice presidents of the company, has been elected president to succeed Stacy C. Richmond, deceased; John L. Harper, chief engineer of the Hydraulic Power Co., which was amalgamated with the Falls Co. last year, has been made a vice president; and Walter H. Schoellkopf has been made a vice president to fill the vacancy caused by the death of Charles D. Hickey.

Griggs & Myers, consulting engineers, New York City, announce their recent affiliation with Charles A. Fuller, heating engineer, of New York, and Osborn Monnett, heating engineer, of Chicago, as associates. Mr. Fuller is a well-known specialist in heating and ventilating and has many important installations to his credit, in industrial plants, office buildings and other structures. Mr. Monnett enjoys a wide reputation as an authority in the field of combustion and power-plant economics, in which he has had an extensive practice.

Metallo Gasket Co. has recently been incorporated at New Brunswick, N. J. The officers of the company are: Zeno Schultes, president and treasurer; George Geipel, vice president; Stanley S. Geipel, secretary. Zeno Schultes was manager of the Goetze Gasket and Packing Co. for about 14 years. George Geipel has been an erecting engineer for 35 years, specializing in refrigerating and steam-power plants, and Stanley S. Geipel has had 10 years' experience in mechanical engineering. The company will concentrate for a time on its metallic corrugated copper gasket with asbestos cord inlaid in the copper grooves or corrugations.

Trade Catalogs

The Steam Motors Co., Springfield, Mass., has issued an instructive 23-page bulletin (No. 5) on "The Steam Motor." The design, construction, application, and specifications of this type of motor are covered. The bulletin is nicely printed and is well illustrated.

The Irving Iron Works Co., Long Island City, N. Y., has issued a 36-page catalog 2-A, entitled "Irving Subway," which contains a very complete description, with illustrations, of grating and grating flooring used for architectural, industrial and marine purposes or where the advantages of a fireproof metallic flooring are sought. The booklet is nicely printed.

The American District Steam Co., of North Tonawanda, N. Y., has just issued a special 80-page catalog descriptive of its central station and interior heating equipment. Also an interesting folder entitled "The Radiator has the Floor" describing the Adsco Vapor Heating System. They will gladly send same to anyone interested.

The Underfeed Stoker Co. of America, Detroit, Mich., has just issued a new edition of the Jones "A-C" catalog. This shows a large sectional reproduction of the stoker in operation, with the fire shown in actual colors. Typical boiler settings are shown under different types of boilers, as well as typical installations of this type of stoker. A copy of the catalog may be had free upon request.

The Jeffrey Manufacturing Co., Columbus, Ohio, has issued its 75-page catalog No. 258, on "Standard Apron Conveyors." This catalog is devoted to installations showing the conveyors in service in various industries, specifications, general dimensions and other data of interest to the purchaser. Pages 4 to 9 contain useful notes that will aid the purchaser in selecting a conveyor.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove	6.20	8.05	Rice	2.75	4.50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.75 @ 2.95	2.95 @ 3.25
Clearfield County	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville	2.50 @ 2.75	2.75 @ 2.95
Quemahoning	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)	2.50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2.35	2.50 @ 2.75
Western Maryland	2.25 @ 2.50	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe	2.10 @ 2.25	2.25 @ 2.40
Greensburg	2.25 @ 2.35	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.05	7.90	Rice	2.75	3.65
Stove	6.30	8.15	Boiler	2.50	3.50
Nut	6.40	8.25	Barley	2.25	3.15
Pea	5.00	6.60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County		
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	.....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

N. Y., Binghamton—The Larrabee Deyo Motor Truck Co., 23 Washington St., will install steam heating plant and electric power in connection with building an addition to its plant. E. M. Hanrahan, Mgr.

N. Y., Black River—The Northern N. Y. Utilities Co., 58 Public Sq., Watertown, will soon receive bids for the construction of a power house, 2500 lin.ft. power, canal, including dam, forebay and tailrace. The company will also install 2 vertical turbine generator units and appurtenances. J. B. Taylor, Pres., H. G. Davis, Ch. Engr. Noted March 11.

N. Y., Bronx—The N. Y. Telephone Co., 15 Dey St., New York City, will install a steam heating plant in the 2 story, 100 x 145 ft. telephone exchange which it plans to build on Tratman Ave., west of Rowland St. Total estimated cost, $200,000. McKenzie, Voorhies & Gmelin, 1123 Broadway, New York City, Engr.

N. Y., Brooklyn—The Board of Education, 500 Park Ave., New York City, will install a steam heating plant in the school which it plans to build on Stillwell Ave. Total estimated cost, $150,000. C. B. J. Snyder, Municipal Bldg., New York City, Engr.

N. Y., Brooklyn—J. Manheimer, 1649 49th St., will install a steam heating plant in the 3 story, 203 x 302 ft. theatre which he plans to build on Flatbush Ave. and Albemarle Rd. Total estimated cost, $450,000. Carlson & Wiseman, 226 Henry St., Arch.

N. Y., Gouverneur—The Board of Education plans to appropriate $25,000 for installing a new heating and ventilating system and new system of sewerage, etc., at the high school on Main and Grove St. Address J. C. Dolan, Pres. of the Bd. of Educ.

N. Y., New York—The Chemung Iron & Steel Co., 39 Cortlandt St., is in the market for one 350 hp., two 100 hp. and three 50 hp. boilers; also 5 horizontal return tubular boilers, to cost about $2100 each. E. Quirk, Engr.

N. Y., New York—J. Eichler Brewing Co., 3582 3rd Ave., will soon award the contract for converting its 3 story, 62 x 84 ft. brewery at 169th St. near 3rd Ave., into an ice plant. Estimated cost, $37,000. A G. Koenig, 405 Lexington Ave., Engr. Noted June 10.

N. Y., Utica—The Utica Suspender Co. is in the market for small motors to drive webbing looms. G. A. Armstrong, Pres. H. G. Sturges, Cox Bldg., Utica.

Penn., Philadelphia—The McCray & Hunter Co., 3525 Germantown Ave., will soon award the contract for the construction of a 2 story, 13 x 72 ft. cold storage plant on Venango near Warnock St.

Penn., Philadelphia—The United Gear Co., 833 North Leighton St., is in the market for one 11-in. Gleason bevel gear generator.

Penn., Pittsburg—The Wappat Gear Works, 7123 Hamilton Ave., is in the market for one 6-in. Gleason bevel gear generator; one 16-in. Gleason bevel gear generator and one 24-in. Gleason forming bevel gear plane.

S. C., Columbia—The city will install a refrigerating plant and slaughterhouse, in connection with the abattoir which it plans to build on Broad River Road. Total estimated cost, $40,000. J. C. Johnson, Palmetto Bldg., Arch.

Ky., Springfield—The Springfield Water & Electric Co. is having plans prepared by H. W. Mayfield, Engr., 298 West Oak St., Ludlow, for changing over their present D. C. light and power plant to an A. C. system; plans include a new 4 panel switchboard, alternators and engines, etc.

Ohio, Dayton—The Brownell Co., North Findlay St., is in the market for an electric traveling crane, 20 ft. bridge span, equipped with 3 motors, 220 v., a.c., 60 cycle, 3 phase.

Mich., Cedar Bank (Forsyth P. O.)—The State Board of Control, Capitol, Lansing, will install a separate power plant to contain 2 boilers, in connection with the administration building, etc., which it plans to build. Total estimated cost, $500,000. B. Wickham, Sec'y. E. A. Bowd, 127 Allegan St., W., Lansing, Arch.

Mich., Detroit—The General Motors Corp., Boyer-Campbell Bldg., will install complete steam heating equipment and auxiliary pumps in the 6 story, 150 x 150 ft. service and sales building which it plans to build on York and Cass Ave. A. Kahn, Marquette Bldg., Arch.

Mich., Port Huron—C. H. Wills and J. R. Lee, Book Bldg., Detroit, have purchased a tract of land on the St. Clair River, south of here, and plan to build a large motor car manufacturing plant. Plans include the construction of a separate power plant and administration building.

Ill., Chicago—The Melville-Clark Piano Co., 25 East Jackson St., has awarded the contract for the construction of a factory on Kedzie Ave. and 48th Place, to R. F. Wilson & Co., 154 West Randolph St. A 300 hp. boiler will be installed in same. Total estimated cost, $400,000.

Wis., Milwaukee—The Fisher Furniture Co., 217-23 2nd St., will install a steam heating system and electric power in the 6 story, 60 x 180 ft. store which it plans to build. Total estimated cost, $250,000. H. M. Buemming, 521 Jackson St., Arch.

Minn., Austin—The city will receive bids in July for installing a boiler and stoking plant at the municipal electric plant. C. L. Pillsbury, 801 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., Minneapolis—The state plans to build new generating units for the electric light plant, to include fire alarm system, etc. Estimated cost, $75,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Engr.

Minn., Walker—The city will receive bids in July for 3 mechanical stokers to be installed at the State Sanitorium. Estimated cost, $5,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Minneapolis, Engr.

Minn., Wells—The city plans to build a power plant and install boiler and stoking equipment. Estimated cost, $75,000. C. L. Pillsbury Co., 801 Metropolitan Life Bldg., Minneapolis, Engr.

Kan., Hiawatha—The city is having plans prepared for improving the waterworks system. Plans include the installation of pumps at the spring on County Farm, etc. Estimated cost, $25,000. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs.

Kan., Sharon Springs—The city plans election soon to vote on $50,000 bonds for the construction of a power house; installing one 150 and one 100 h.p. engines; and improving the distributing system.

Kan., Topeka—The state will install a complete heating plant in the state house which it plans to build on 9th and Jackson St. Estimated cost, $50,000. R. S. Gamble, Arch.

Mo., St. Joseph—The city voted $500,000 bonds for improving the electric lighting plant. E. M. Stephens, Kansas City, Engr. Noted March 11.

Okla., Tahlequah—The city voted $200,000 bonds for the construction of a light and power plant.

Okla., Tulsa—The city plans to build a waterworks system, water to be taken from the Spavinaw Creek. Total estimated cost, $4,853,020. Project includes dam and power house to cost $248,445; land and clearing, $150,000; conduit, $2,900,405; right of way, $50,000; three reservoirs of 20,000,000 gal. capacity, $225,000, and 1 reservoir near the city limits to have a capacity of 80,000,000 gals., $314,000; power plant, $225,000; pumping plant, $150,000; transmission lines, $360,000; engineering, $230,170. H. A. Pressey, City Hall, Engr.

Okla., Tulsa—The Hinderlila Tool Co., 2-3-4 Madison St., will install a 20 hp. engine in connection with 1 story, 68 x 125 ft. factory which it plans to build on Madison St. Estimated cost, $6,000. Engineer not selected.

Ariz., Duncan—The Ash Peak Mines Co. plans to build a power plant. A. Murphy, Jr., Supt.

Ariz., Mesa—The city plans election soon to vote on $60,000 bonds for extensions to the gas plant, installing additional electrical equipment and improvements to the water system.

Wash., Oroville—The Okanogan Power Co., 521 1st Ave., Spokane, which now has an investment of $350,000 in the Okanogan mining country, has had plans prepared for the construction of a 60 x 350 ft. dam and the machinery for the first unit of a large power plant at a point on the Similkameen River, three and a half miles above Oroville; 2000 hp. will be available from the new plant with the completion of the first unit and the generation of 3000 additional hp. is anticipated from the second unit, which will probably be available early next year. Estimated cost, $150,000. E. Enloe, Spokane, Mgr.

Ore., Klamath Falls—The Klamath Heating Co. plans to build a central heating plant, etc. Estimated cost, $40,000. Funds to be supplied by local capitalists.

Cal., Altadena—The Rubio Canyon Land & Water Association plans to build a pumping plant on Sacramento St. and lay a pipe line to the reservoir. Estimated cost, $10,000.

Cal., Los Angeles—The Board of Public Service Commission, 645 South Olive St., voted $13,500,000 bonds, $2,500,000 to be used for the construction of power plant No. 2 in the San Francisquito canyon and power development in the Owens River gorge, and $11,000,000 for purchasing the distribution system in Los Angeles owned by the Southern California Edison Co. E. F. Scattergood, 645 South Olive St., Engr. Noted June 3.

Que., Verdun—The city plans to improve the electric lighting plant and is in the market for one 1000 kw. steam turbine generator and boilers. Estimated cost, $125,000. G. E. Ghysene, City Hall, Engr.

Ont., Boston Creek—The Northern Ontario Light & Power Co., Timmins, plans to build an electric power station and is in the market for equipment for same.

Ont., Niagara Falls—The City Council plans to extend the hydro-electric system. Estimated cost, $18,000.

Ont., Guelph—The Northern Rubber Co., Ltd., will soon receive bids for the construction of a 1 story, 35 x 45 ft. power house, to be equipped with two 125 hp. boilers, a water heater and a 6 x 6 x 8 ft. vacuum steam pump to handle 15,000 sq.ft. radiation. Plans include the installation of a vacuum steam heating plant. Estimated cost, $20,000. James, Loudon & Hertzberg, 36 Toronto St., Toronto, Engrs.

Ont., Lakefield—G. K. Fraser plans to build an electric lighting plant and is in the market for equipment for same.

Ont., Parry Sound—The Town Council will receive bids for the construction of a power dam, intake, conduit, generating station and tailrace, etc. C. H. Mitchell, 1003 Bank of Hamilton Bldg., Toronto, Engr.

Ont., Scarboro—The city plans to build a pumphouse, water mains, etc. Estimated cost, $150,000. James, Loudon & Hertzberg, 36 Toronto St., Toronto, Engrs.

Ont., Scarboro—The Gendron Manufacturing Co., Ltd., 137 Duchess St., Toronto, plans to build a boiler house and install a vacuum steam heating system in connection with the plant which it plans to build. Total estimated cost, $500,000. James, Loudon & Hertzberg, 36 Toronto St., Toronto, Engrs.

CONTRACTS AWARDED

N. Y., Albany—E. L. Walsh, Supt. of Public Wks., haas awarded the contract for furnishing, testing and delivering battery charging motor generator sets with switchboard panels for the barge canal terminals in New York City, Contract 117, to the Electric Products Co., 1067 East 152nd St., Cleveland, $5,293.

Va., Hampton Roads—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing motor generator sets and switchboard at the Submarine Base, here, to the General Electric Co., River Road, Schenectady, N. Y. Estimated cost, $44,050. Noted June 3.

Miss., Hollandale—The Commissioners of Black Bayou D. D., Greenville, has awarded the contract for the construction of a 1 story pumping plant, sluiceways, etc., here, to the Delta Cement Tile Co., Greenville. Estimated cost, $24,600. Noted April 22.

Mich., Highland Park (Detroit P. O.)—The city has awarded the contract for the construction of a 4 story hospital and 2 story power house and laundry, etc., to the O. Rosenthal Construction Co., 603 Railway Exchange, Chicago, Ill. Estimated cost, $241,600.

Wis., Milwaukee—The Wisconsin Dye Works, 614 Mitchell St., has awarded the contract for the construction of a 1 story, 18 x 40 ft. boiler house, to H. Breest, 1152 9th St.; contract for installing boiler in same has been awarded to Schwab-Lezotte, 16th and Canal St.

Kan., Rosedale—The Kaull Mills Co. has awarded the contract for the construction of a mill, warehouse and a 1 story, 22 x 36 ft. boiler house, to the Eberhardt Construction Co., Salina. Estimated cost, $100,000.

Neb., York—The Lutheran Hospital has awarded the contract for the construction of a 2 story hospital and boiler house to A. J. Olson, 520 Reliance Bldg., Kansas City, Mo. Estimated cost, $75,000.

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Men
Jobs
Wants

Business Opportunities
Equipment Bargains
Wants
Jobs
Men

Equipment Bargains
Business Opportunities

all the worth-while "Opportunities" of the power plant field. You will find them in the

SEARCHLIGHT SECTION

SEE PAGES 51 TO 64.